

Trimble TX5

3D Laser Scanner

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For implementation notes for third-party software, [Appendix A: Implementation Notes, page 108](#).

Release Notice

This is the October 2012 release (Revision A) of the Trimble TX5 3D Laser Scanner User Guide. It applies to version 1.00 of the receiver firmware.

Notices

For FCC compliance information, see [Appendix B: FCC Compliance, page 115](#).

For the assessment of risk of ocular injury from using the laser scanner, refer to the expert opinion provided at the end of this guide.

Product Limited Warranty Information

For applicable product Limited Warranty information, refer to the warranty information provided at the end of this guide.

End User License Agreement

For details of the software EULA, refer to the EULA provided at the end of this guide.

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Introduction

In this chapter:

- [The Trimble TX5 3D laser scanner](#)
- [How the laser scanner works](#)
- [Equipment](#)

The Trimble TX5 3D laser scanner

The Trimble® TX5 3D laser scanner is a high-speed three-dimensional laser scanner for detailed measurement and documentation. The laser scanner uses laser technology to produce exceedingly detailed three-dimensional images of complex environments and geometries in only a few minutes. The resulting images are an assembly of millions of 3D measurement points.

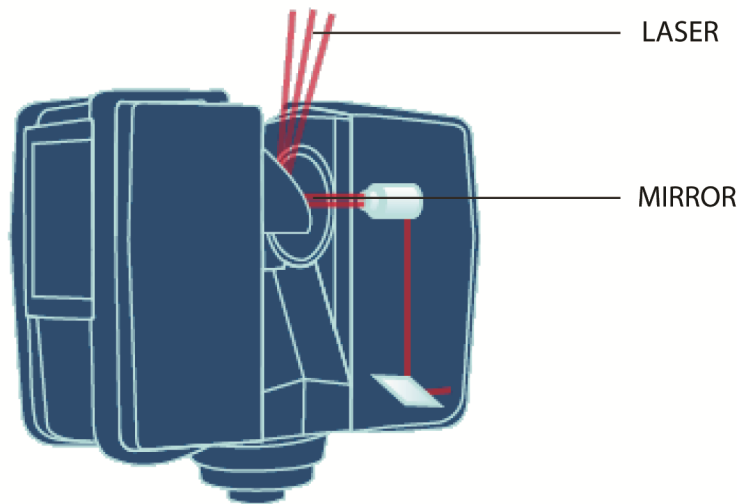


The main features are:

- High accuracy.
- High resolution.
- High speed.
- Intuitive control via the built in touchscreen display.
- High mobility due to its small size, light weight, and the integrated quick charge battery.
- Photorealistic 3D color scans due to the integrated color camera.
- Integrated dual axis compensator to automatically level the captured scan data.
- Integrated compass and altimeter to give the scans an orientation and a height information.
- WLAN to remotely control the scanner.

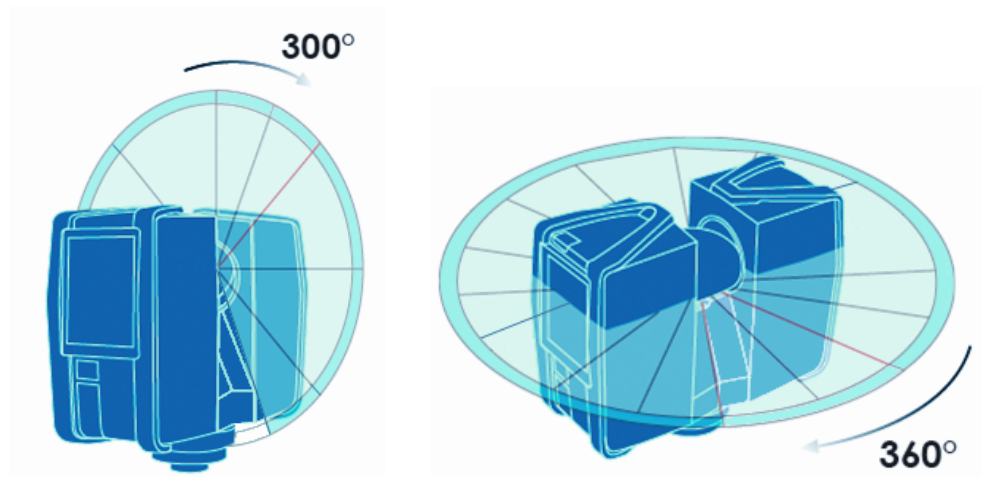
How the laser scanner works

In principle, the TX5 3D laser scanner works by sending an infrared laser beam into the center of its rotating mirror. The mirror deflects the laser beam on a vertical rotation around the environment being scanned; scattered light from surrounding objects is then reflected back into the scanner.



To measure the distance, the laser scanner uses phase shift technology, where constant waves of infrared light of varying length are projected outward from the scanner. Upon contact with an object, they are reflected back to the scanner. The distance from the scanner to the object is accurately determined by measuring the phase shifts in the waves of the infrared light.

HYPERMODULATION greatly enhances the signal-to-noise ratio of the modulated signal with the help of a special modulation technology. The x, y, z coordinates of each point are then calculated by using angle encoders to measure the mirror rotation and the horizontal rotation of the laser scanner. These angles are encoded simultaneously with the distance measurement. Distance, vertical angle and horizontal angle make up a polar coordinate (δ, α, β), which is then transformed to a Cartesian coordinate (x, y, z). The scanner covers a $360^\circ \times 300^\circ$ field of view.



Additionally, the laser scanner determines the reflectivity of the captured surfaces by measuring the intensity of the received laser beam. In general, bright surfaces reflect a greater portion of the emitted light than do dark surfaces. This reflectivity value is used to assign a corresponding grey value to each single point.

The single point measurements are repeated up to 976,000 times per second. The result is a point cloud, a three-dimensional dataset of the scanner's environment (hereinafter referred to as the "laser scan" or "scan"). Depending on the selected resolution (points acquired per rotation) each point cloud consists of millions of scan points.

The laser scans are recorded to the removable SD memory card, enabling easy and secure transfer to Trimble TX5 SCENE software.

For a list of the potential fields of application of the TX5 3D laser scanner, go to www.trimble.com.

This manual provides an introduction to the TX5 3D laser scanner. At a minimum, please read [Safety Precautions and Maintenance \(page 12\)](#) and [Getting Started \(page 32\)](#) before first use.

Equipment

The TX5 3D laser scanner is shipped with the following equipment:



- ❶ Scanner transport and carry case
- ❷ AC power cable
- ❸ External power supply unit with cable
- ❹ PowerBlock battery
- ❺ Memory card case
- ❻ USB memory card reader
- ❼ Laser safety goggles
- ❽ Quick Start Guide, situated in the case lid
- ❾ CD with TX5 SCENE software and this user guide, located in the case lid

In addition, an SD memory card is located inside the scanner.

Recommended optional equipment

- Tripod
- Quick Release for convenient mounting of the laser scanner to the tripod
- Spare battery
- PowerDock charging cradle

Retain all packing materials as you may need them later.

The SD memory card, a charged PowerBlock battery or the external power supply unit with AC power cable, and a tripod are the minimum required equipment you need to carry out a scanning project.

Safety Precautions and Maintenance

In this chapter:

- [General safety information](#)
- [Electrical safety](#)
- [Laser safety](#)
- [Mechanical security](#)
- [Transport](#)
- [Storage](#)
- [Maintenance](#)

General safety information

- Read this User Guide carefully and refer to it. Pay close attention to all warnings and follow the instructions step by step.



CAUTION – Do not open the housing as this may damage the product, which will affect the product's warranty.

- Servicing and repair must only be done by qualified service personnel authorized by Trimble.
- Unplug this product from the power outlet, remove the battery and refer servicing to qualified service personnel under the following conditions:
 - The power-supply cord or plug is damaged.
 - The product has been exposed to rain, water, or other liquids.
 - The product has been dropped or damaged in any way.
 - Objects have fallen onto the product.
 - The product does not operate normally by following the operating instructions.
 - The product exhibits a distinct change in performance.
 - The required service and calibration date is reached.
- Only replacement parts authorized by Trimble may be used according to the instructions obtained from Trimble. For a list of available replacement parts, see [Available replacement parts, page 99](#).
- Do not expose the product to extreme temperatures. The ambient temperature should not be lower or higher than given in the specifications. Do not use the laser scanner near heat sources such as radiators, heat registers, or other products (including amplifiers) that produce heat.
- Do not immerse the product into water. Liquid in the product's enclosure can lead to damage, fire, or electric shocks.
- Do not use the laser scanner in vicinity of strong magnetic or electrical fields.
- For outdoor use, use the PowerBlock battery as the power supply and ensure that the device is protected from rain or spray water. The scanner should be used in a non-condensing environment.
- When the product is transferred from a cold to a significantly warmer environment, water may condense on some elements inside the scanner. To avoid this, we recommend placing the scanner in an airtight plastic bag before bringing it from a cold to a significantly warmer environment. This allows the condensation to form on the bag and not inside the scanner. If you do not have the possibility to pack the scanner airtight, please wait until observable condensation water evaporates from the scanner before switching on the laser scanner.
- Properly dispose of the product and batteries in accordance to the national regulations. For more information, see [Notices, page 2](#).

Electrical safety



WARNING – Do not open the housing. Dangerous high voltages are present inside the enclosure. Only qualified service personnel should open the cabinet. Never push objects of any kind into this product through openings as they may touch dangerous voltage points or cause short circuits. This could result in a fire, electric shock, and damage to the product.

This product should be operated only from the power source or the battery supplied or recommended by Trimble. Please ensure that the specifications of the AC converter are met by your line voltage. If you do not know the power line voltage in your area, please consult your local power company.

To avoid electrical shock, use the power supply unit in dry indoor environments only.

PowerBlock battery safety

The following safety measures must be followed when working with the PowerBlock battery:

- Only use the charger recommended by Trimble to charge the battery.
- Do not charge or discharge damaged batteries.
- Do not charge the battery in the laser scanner when it is stored in the transport case.
- Do not use wet or dirty batteries in the laser scanner or with the charger.
- Charge within limits of 0°C (+32°F) and 45°C (113°F) temperature. Recommended charging temperatures: 10°C (50°F) to 30°C (86°F).
- Discharge within limits of -20°C (-4°F) and 60°C (140°F) temperature. Recommended operating temperatures: 5°C (41°F) to 40°C (104°F).
- Insert or remove batteries from the laser scanner in dry and dust-free environments only.
- When the laser scanner is not in use for a longer period of time, remove the battery.
- Store the battery only when it is charged (at least 60% charge state). It is recommended to charge the battery once a year when it is stored long-term.
- Storage temperatures: -20°C (-4°F) to 45°C (113°F), storage humidity range: 0% to 80%. Store in a well ventilated area. Do not store with metal objects. Short circuit can cause burn.
- Do not bring metal objects into contact with the batteries' terminals. The terminals may short circuit and generate heat in this condition.
- Do not immerse batteries into water or fire (danger of explosion).
- Dispose of batteries in accordance with environmental regulations. Contact your local waste disposal management authority for guidelines concerning lithium ion batteries.

PowerDock battery charger safety

Observe the following safety measures when working with the Trimble PowerDock battery charger. The charger is available as an optional accessory:

- Do not charge any batteries other than the Trimble PowerBlock batteries in the PowerDock battery charger.
- Regularly check plug, cord and the charger itself. In case of damage contact Trimble Support.
- Do not bring metal objects into contact with the charger terminals. The terminals may short circuit and generate heat in this condition.
- To avoid electrical shock, use the charger and the power supply unit in dry indoor environments only.
- Do not operate the charger in an environment allowing exposure to moisture, combustible fluids or gasses. Danger of explosion!
- The charger should be kept in a dry room, out of the reach of children.

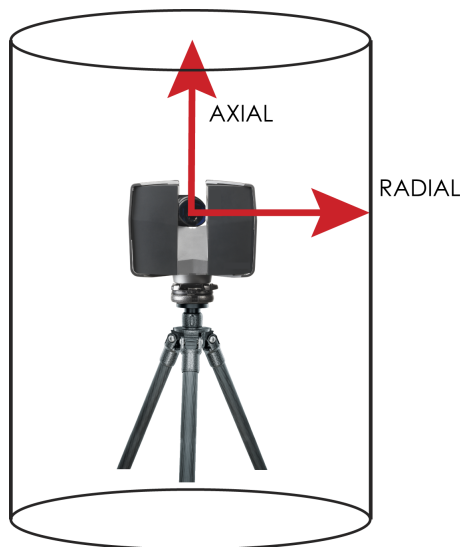
Laser safety

The TX5 3D laser scanner produces an invisible laser beam with a wavelength of 905nm. The average laser power maximum is 20mW and the beam divergence is typically 0.19 mrad (0.011°).

In accordance to the standard IEC 60825-1:2007, Ed 2.0, the TX5 3D laser scanner is classified as a Class 3R laser system. According to this standard, direct intrabeam viewing may be hazardous for the eyes when working within an area around the Class 3R laser system where the defined exposure limits are exceeded.

However, exceeding the exposure limits does not necessarily mean that an actual risk for injury exists. An analysis comparing the exposure levels of the eye that can be produced by the TX5 3D laser scanner with injury thresholds for the retina in order to assess the risk for ocular injury when exposure occurs, comes to the conclusion that **"exposure of the eye under normal conditions, as well as for reasonably foreseeable worst-case conditions, should not induce ocular injury."** For more information, refer to the expert opinion included at the end of this guide. From a biophysical point of view, the TX5 3D laser scanner can thus be considered as eye safe and it would not be necessary to wear eye protection.

However, depending on national regulation or work place safety legislation, it might be necessary to wear eye protection and to observe other safety measures when the defined exposure limits are exceeded and when exposure can occur. To enable the user to identify the laser hazard area (nominal ocular hazard area – NOHA) around the scanner within which the defined exposure limits are exceeded, the TX5 Controller software shows the actual valid eye safety distance (nominal ocular hazard distance – NOHD). We differentiate between the axial and the radial NOHD. The resulting NOHA surrounding the scanner can thus be described as a cylinder along the scanner's Z axis of rotation, where the radial NOHD is equivalent to the cylinder's radius and the axial NOHD is equivalent to its center line coming from the center of the scanner mirror.



Both, the axial and the radial NOHD are dependent on the requested scanning resolution and quality (see [Setting the scan parameters, page 46](#)). The table below contains the axial and radial NOHD (in meters), repetition rate and pulse duration for all resolution and quality combinations that are available.

Resolution Mio. Pts (full scan)	Quality	Repetition rate (Hz)	Pulse duration (μs)	NOHD (m)	
				axial	radial
710.7	1/1	1x	24	13.081	7.50 3.60
710.7	1/1	2x	12	15.026	12.50 6.30
710.7	1/1	3x	6	17.268	20.30 10.90
710.7	1/1	4x	3	23.155	29.40 16.20
177.7	1/2	1x	48	13.081	4.50 1.80
177.7	1/2	2x	24	15.026	7.50 3.20
177.7	1/2	3x	12	17.260	12.50 5.50
177.7	1/2	4x	6	22.689	20.30 8.30
177.7	1/2	6x	3	23.155	29.40 16.20
44.4	1/4	1x	95	44.083	2.70 0.30
44.4	1/4	2x	48	15.026	4.50 1.60
44.4	1/4	3x	24	17.260	7.50 2.80
44.4	1/4	4x	12	22.686	12.50 4.20
44.4	1/4	6x	6	22.689	20.30 8.30
44.4	1/4	8x	3	23.155	29.40 16.20
28.4	1/5	2x	60	15.026	3.80 1.30
28.4	1/5	3x	30	17.260	6.30 2.20
28.4	1/5	4x	15	22.686	10.60 3.30
28.4	1/5	6x	7.5	22.689	20.30 8.30
11.1	1/8	2x	95	88.072	2.70 0.20
11.1	1/8	3x	48	17.260	4.50 1.40
11.1	1/8	4x	24	22.686	7.50 2.10
11.1	1/8	6x	12	22.686	12.50 4.20
11.1	1/8	8x	6	22.689	20.30 8.30
7.1	1/10	3x	60	186.912	3.80 0.70
7.1	1/10	4x	30	22.686	6.30 1.70
7.1	1/10	6x	15	22.686	10.60 3.30
7.1	1/10	8x	7.5	22.689	20.30 8.30
2.8	1/16	3x	95	116.820	2.70 0.10
2.8	1/16	4x	48	233.640	4.50 0.90
2.8	1/16	6x	24	22.686	7.50 2.10

Resolution		Quality	Repetition rate (Hz)	Pulse duration (μs)	NOHD (m)	
Mio. Pts (full scan)					axial	radial
2.8	1/16	8x	12	22.686	12.50	4.20
1.8	1/20	4x	60	186.912	3.80	0.40
1.8	1/20	6x	30	22.686	6.30	1.70
1.8	1/20	8x	15	22.686	10.60	3.30
0.7	1/32	4x	95	116.820	2.70	0.10
0.7	1/32	6x	48	233.640	4.50	0.90
0.7	1/32	8x	24	22.686	7.50	2.10

When working with the laser scanner you should be aware of the following laser safety measures:



WARNING – This product employs a laser system. To prevent direct exposure to the laser beam, do not attempt to open the enclosure.



WARNING – Use of controls or adjustments or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

- Avoid looking into the direction of the laser. Avoid direct eye exposure, do not stare into the laser beam and do not direct it to other people.
- Do not view the laser beam directly with optical instruments.
- Do not place mirrors or objects with reflective surface into the beam. The mentioned safety measures are also valid for the reflected laser beam.
- The scanner should be operated by trained personnel only.
- The customer should assess the proper functioning of the delivered laser scanner at regular intervals. You should immediately stop further use of the laser scanner if any failure is found. It should be regularly checked and certified by a Trimble service provider. The service intervals should not exceed a maximum period of one year. For more information, contact your Trimble dealer.
- Respect the safety precautions and control measures that are specified in IEC 60825-1:2007, Ed 2.0. Also respect differences to the mentioned safety precautions and control measures that may exist in national or regional publications.

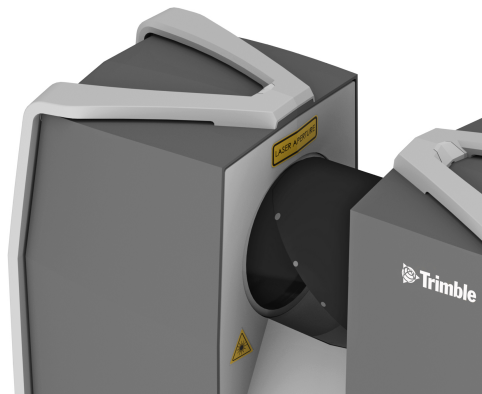
Depending on national regulation or work place safety (health and safety at the workplace) legislation, further laser safety measures might be necessary, such as:

- Personnel working in distances shorter than the NOHD must wear laser safety goggles.
- Prevent people without laser safety goggles from entering the NOHA (for example, by using a safety fence).
- The NOHA should be posted with appropriate laser warning signs and should be demarcated.
- Companies working with Class 3R laser systems have to appoint a laser safety officer.

Note – These mentioned laser safety measures raise no claim to completeness. Please refer to your national regulations and legislations for more information on required laser safety measures when working with Class 3R laser systems.

If working with laser safety goggles, they must be selected for the specific type of laser. For the TX5 3D laser scanner, use goggles which are specified for DI 800-980 L5 or higher. D stands for continuous wave laser mode, I for pulsed laser mode, 800-980 describes the laser wavelength, and L5 is the L-rating, which is used to indicate the level of protection provided for specific wavelength ranges. Please refer to your laser safety commissioner for more information.

In accordance with IEC 60825-1:2007, Ed 2.0, the TX5 3D laser scanner is equipped with the following laser signs:





The TX5 3D laser scanner stays within the limits of laser class 1 if all instructions of this manual are obeyed, especially if no one is allowed to enter the NOHD without wearing laser safety goggles.

Mechanical security

The laser scanner may only be used when set on a flat and stable surface. Severe injuries may result if the laser scanner overturns. Only use equipment recommended by Trimble and follow the setup instructions in this manual or in the manual of the manufacturer of the equipment.

If using a cart, move the setup with special care. Never move the cart by pulling at the power cables. Pushing or pulling of the cart with too much force, sudden stops, or an uneven surface can cause an upset of the laser scanner.

The laser scanner will rotate clockwise up to 360 degrees when performing a scan. Ensure that the case of the laser scanner can rotate freely and will not hit any objects during the scan.

The mirror unit rotates with high speed while scanning and for a short period after the scan. Do not touch the rotating mirror unit with your hands or any objects at the risk of personal injury and damage to the laser scanner.

Transport

When carrying the laser scanner, take care not to drop it. Strong impact may damage the laser scanner and render it incapable of proper operation. Carry the laser scanner separately from its equipment or – for best protection – use the original transport case.

When shipping and transporting the laser scanner by rail, sea, air, or in a road vehicle, make sure to use its original transport case and a suitable outer cardboard box for best protection against shock and vibration.

The PowerBlock batteries are Li-Ion batteries and are thus classified as "dangerous goods". When transporting or shipping the PowerBlock batteries, please ensure that you observe the applicable and international rules and regulations. For further information, please contact your local forwarder before transportation or shipping.

For Li-Ion batteries with less than 100 Wh energy content, an exemption is provided that allows you to carry such a battery without further paperwork. The maximum Li-Ion battery energy a single person may carry is 200 Wh.

Note – Make sure that the total energy content of all Li-Ion batteries that you (as a single person) carry is less than 200 Wh and that no single battery has more than 100 Wh energy content.

Note – The laser scanner must be turned off during transportation or shipping in a transport case. Remove the battery from the laser scanner before shipping.

Storage

Prior to storing the laser scanner for a longer time, remove the battery. Pack the scanner and the battery in its shipping case to protect it from environmental hazards, dust, and dirt. Store all components in an environment where the humidity level is low, the temperature is relatively stable, and where they will not be subject to extreme temperatures, environmental conditions, or heavy vibrations.

Maintenance

General

It is recommended that you check your laser scanner at least once a month. This enables you to spot trouble before it starts and helps provide you with an efficient measuring system.

The laser scanner is a precision instrument that contains many sensitive components, and it must be handled with care. Follow these procedures to prevent problems with your system:

- Check the cables for damage to outside insulation, connectors, and pins.
- Check the housing of the scanner for damage.
- Check the housing and the connectors of the battery for damage.
- Place a dust cover over the laser scanner when it is not in use.
- Do not lubricate the laser scanner.

To ensure proper functioning of the laser scanner, it should be regularly checked and certified by a Trimble service provider. The service intervals should not exceed a maximum period of one year. For more information, contact your Trimble dealer.

Cleaning instructions for optics

Note – *To avoid unnecessary damage or wear, only clean the optics when the degree of contamination has an impact on the scan quality (e.g. an increase in range noise or a decrease in scan range) and requires cleaning for proper function.*

Major contamination and improper handling to clean optics may impact the scanning quality. ***Self-caused damages can result in a complete replacement of the part at the expense of the customer.***

- We recommend using latex gloves. If you are suffering from latex allergies please use gloves that are suitable for you. Lightly rub the gloves after taking them off with laboratory cloths and isopropanol to remove grease and dirt.
- Do not touch the optical surfaces with bare hands or laboratory gloves if at all possible.
- Turn the scanner off before cleaning the optics.

Note – *Before cleaning the mirror optics, cover the lens with a cap and avoid any contact with the lens.*

- **Only use cleaning fluid WITHOUT alcohol or acetone** to clean the optics. We recommend alcohol-free lens cleaner that can be found in most optical supply stores.
- In the event acetone accidentally comes in contact with the mirror or lens, IMMEDIATELY rinse with water (distilled, if possible).

What's needed:

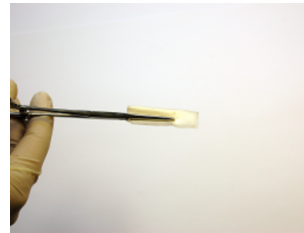
- Compressed air spray (oil-free - optical supply store)
- Alcohol free cleaning fluid in spray bottle / dropping bottle
- 1 Package lens tissue (optical supply store)
- 1 Package laboratory cloths (lint-free)
- 1 Pair of tweezers or forceps
- 1 Pair of non-powdered gloves

Additionally for a greatly contaminated mirror:

- Mild neutral soap (optical supply store)

Slightly contaminated mirror

Handling lens tissue: Fold two or three pieces of lens tissue and clamp them in the tweezers or forceps.

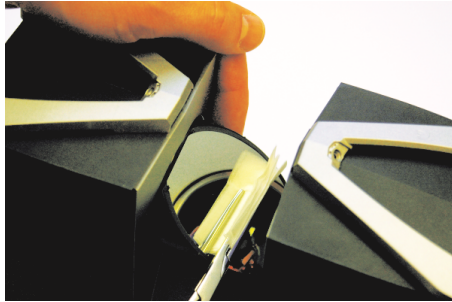


- First, use a little compressed air spray (oil-free) to clean the surface of the optics.
- Mist the clamped lens tissues with the cleaning fluid (do not soak). If necessary, wait a few seconds until some of the solution has evaporated.



- Bring the scanner mirror into position and hold it with one hand; do not touch the mirror surface. Use the other hand to clean the mirror. Starting at the edge of the mirror, apply light pressure and wipe across the mirror into one direction. Repeat until the mirror surface is clean. Use a clean area of the lens tissue (fold used lens tissue accordingly) or new lens tissue for each

wipe. Avoid touching the mirror surface with gloves. Do not touch the mirror surface and the receiver lens with the tweezers or forceps.



Greatly contaminated mirror

Folding laboratory cloths: Take several individual laboratory cloths out of the package and fold twice. Set onto an oil-free surface.

- Fold the laboratory cloth and soak the edge in the cleaning fluid. Carefully clean the edge of the mirror.
- Completely mist a fresh folded laboratory cloth with mild neutral soap along the edge.
- Starting at the edge of the mirror, apply light pressure and wipe across the mirror. Repeat multiple times in linear direction.
- Then clean with appropriate cleaning fluid. See [Cleaning instructions for optics, page 22](#).

Cleaning the receiver lens

See [Cleaning instructions for optics, page 22](#). Use only alcohol free cleaning fluids. Do not touch the mirror or the receiver lens with your hands, tweezers or forceps.

- Even small amounts of acetone on the lens may result in dullness of the lens surface or cracks in the lens body.
- ATTENTION: To avoid unnecessary damage or wear, only clean optics when the degree of contamination requires cleaning for proper function.
- Major contamination and improper handling to clean optics may impact the scanning quality. ***Self-caused damages can result in a complete replacement of the part at the expense of the customer.***

Suppliers

Gloves, lens tissues, laboratory cloths, tweezers, forceps, cleaning fluids: Thorlabs, Inc. (www.thorlabs.com) or Edmund Optics (www.edmundoptics.com)

Cleaning set: Kugler GmbH (www.kugler-precision.com)

Parts and their Functions

In this chapter:

- [Scanner – right side](#)
- [Scanner – left side](#)
- [Scanner – front](#)
- [Scanner – bottom](#)
- [PowerDock battery charger cradle](#)

Scanner – right side



1 Power button

Press this button to power on the laser scanner. If the laser scanner is on and running, press this button to power down the laser scanner.

Pressing and holding the button more than 4 seconds will switch off the laser scanner without shutting down. Only use this option in exceptional cases; for example, if the shutdown mechanism does not work or the laser scanner is non-responsive.

2 START/STOP button

Press this button to start or stop recording a scan.

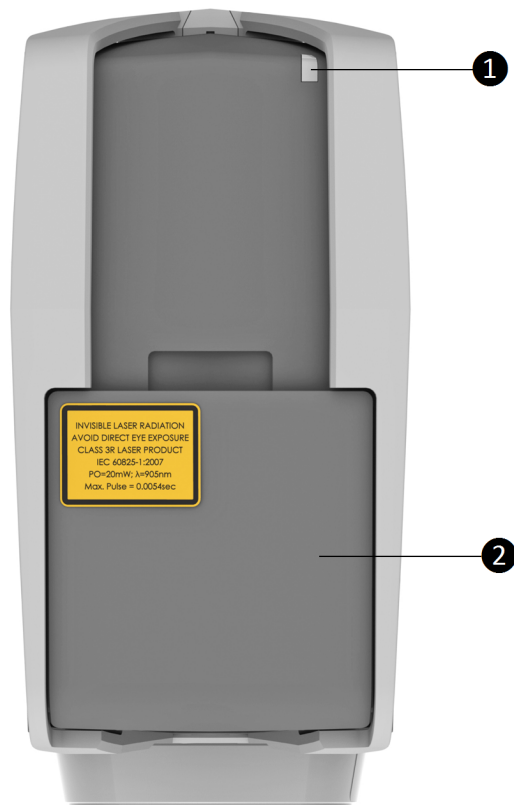
3 SD memory slot and cover

Open the cover to insert a card into or release a card from the card slot. For more information, see [Using an SD memory card, page 37](#).

4 LED on mirror side of the scanner

5 Touch screen display

Scanner – left side



- ❶ Battery compartment
Open the cover and press the fastener to release the battery
- ❷ LED sensor side

Scanner – front



❶ Scanner mirror

For safety and cleaning instructions see [Mechanical security, page 21](#) and [Cleaning instructions for optics, page 22](#).

❷ Reference area

Used to adjust distance measurements while scanning. Avoid soiling this area and do not touch it.

❸ Scanner mount

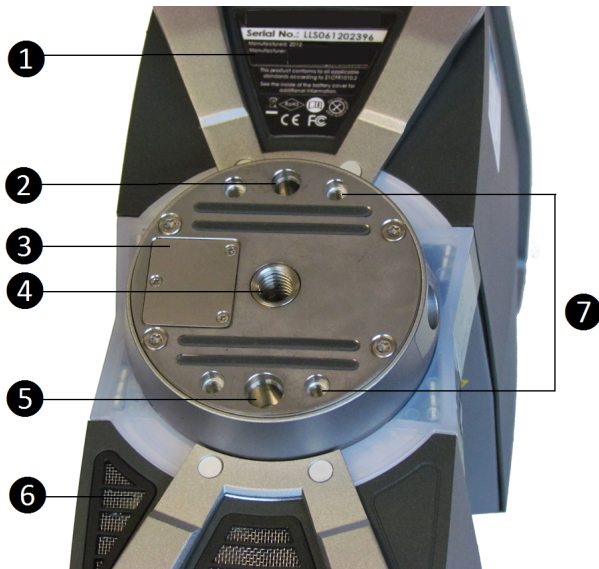
See [Scanner – bottom, page 29](#).

❹ LED on scanner mount

❺ Power socket

For the pin assignment of the power socket, see [Laser scanner power socket, page 106](#).

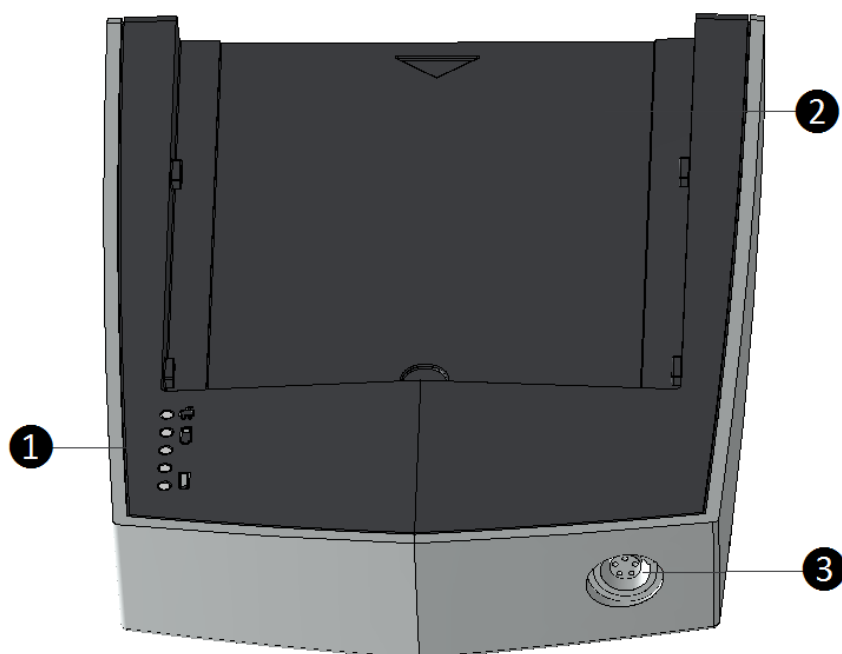
Scanner – bottom



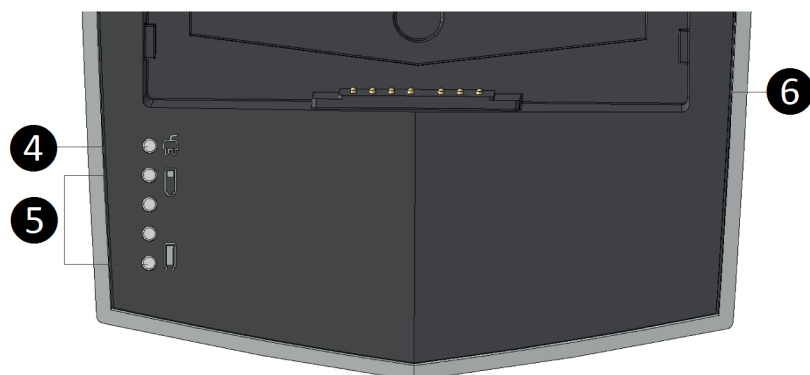
- ① Type label
- ② Pin hole (diameter 6 mm) for scanner adjustment
- ③ Cover of the automation interface for automated applications
Remove to get access to the automation interface of the laser scanner. For more information, refer to the *Trimble TX5 Automation Interface Guide*. Cover the automation interface if it is not needed or not in use.
- ④ 3/8" screw thread to mount the scanner to standard photo tripods
- ⑤ Pin hole (diameter 8 mm) for scanner adjustment
- ⑥ Cooling fan openings
Keep these openings uncovered to ensure proper cooling of the scanner
- ⑦ M5 screw threads to mount the scanner to customer specific fixtures

For a detailed sketch of the scanner mount, see [Mount dimensions, page 104](#).

PowerDock battery charger cradle



- ① LEDs (see below)
- ② Bearing area for the battery
- ③ Power socket



- ④ Power LED (LED 1). Indicates that power is connected to the PowerDock.
- ⑤ LEDs 2–5. Indicate the charging status of the battery.
- ⑥ Connectors

Normal LED behavior

Charge level	LED behavior
0–25%	LED 2 is blinking yellow, others are off
25–50%	LED 2 is illuminating yellow, LED 3 is blinking yellow, LEDs 4 & 5 are off
50–75%	LEDs 2 & 3 are illuminating yellow, LED 4 is blinking yellow, LED 5 is off
75–99%	LEDs 2 to 4 are illuminating yellow, LED 5 is blinking yellow
Fully charged	LEDs 2 to 5 are illuminating yellow

LED behavior in case of errors

Error	LED behavior
Temperature too low	LED 2 is blinking red
Temperature too high	LED 5 is blinking red
Battery is defective	LEDs 2 to 5 are blinking red
Power supply has under- or over- voltage	LED 1 is blinking red

Getting Started

In this chapter:

- [Charging the battery](#)
- [Setting up the tripod](#)
- [Mounting the laser scanner](#)
- [Using an SD memory card](#)
- [Powering the laser scanner](#)
- [Powering on the laser scanner](#)
- [Initial scanner settings](#)
- [Scanning](#)
- [Shutting down the laser scanner](#)
- [Powering off the laser scanner](#)

This chapter provides preliminary steps and basic laser scanner operations and will guide you step-by-step from setting up the laser scanner to recording your first scan.

Charging the battery

The PowerBlock battery can be charged in the laser scanner or in the PowerDock battery charger which is available as an optional accessory. Carefully read the safety measures described in [PowerBlock battery safety, page 14](#) and [PowerDock battery charger safety, page 15](#) before using them.

It is recommended to fully charge the battery before use and that a spare battery is kept on hand just in case it is needed during your scan project.

Charging the battery in the laser scanner

The laser scanner doesn't need to be switched on in order to charge the battery.

1. Mount the battery into the laser scanner. See [Supplying power with the battery, page 38](#).
2. Connect the AC adaptor to the laser scanner and the wall outlet. See [Supplying power with the external power supply unit, page 39](#).
3. If the laser scanner is turned off, the upper LEDs on both sides of the scanner as well as the LEDs at the scanner mount will start blinking slowly yellow while charging. The LEDs will stop blinking and will illuminate constantly yellow when the battery is fully charged.
4. If the laser scanner is turned on, you can check the exact charge state of the battery in the scanner's user interface under *Manage / General Settings / Power Management*.

Please note:

- Take out the laser scanner from the transport case before connecting the power supply to the scanner.
- Use the power supply unit indoors only.
- Before longer storage, remove the power supply unit and the battery from the laser scanner.

Tips for using the battery

Charge the battery the day it is to be used or on the day before. A charged battery unused will gradually lose power over time.

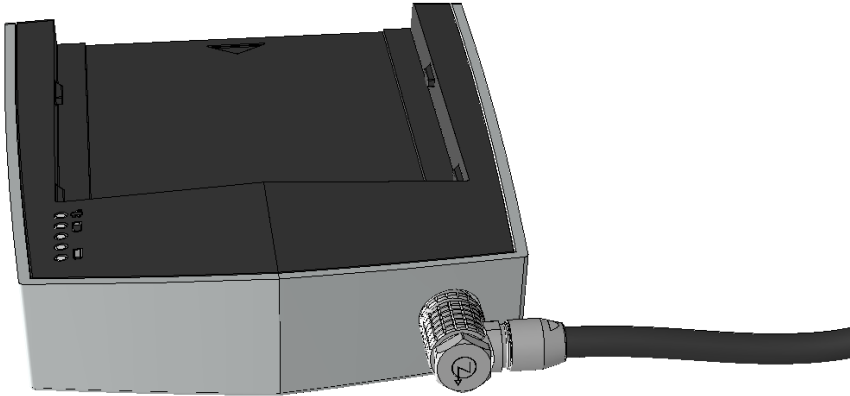
If the battery becomes exhausted quickly after being fully charged, replace it with a new one.

For best battery performance, an ambient temperature of 5°C (41°F) to 35°C (95°F) is recommended. In colder or warmer locations, battery performance and operation time may temporarily decrease.

Charging the battery with the PowerDock battery charger

The charger can be used in foreign countries. It is compatible with a 100 V AC to 240 V AC 50/60 Hz power source. Use a plug adapter for other countries.

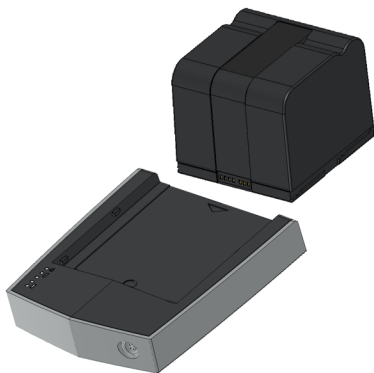
1. Connect the power supply unit cable to the power socket of the PowerDock charger. Confirm the direction of the power supply's plug. If you forcibly insert the plug in a wrong direction, the plug, the charger's power socket as well as the charger itself can be damaged.



2. Connect the AC power cable to the power supply as well as to a power outlet. Check the input voltage on the type label before connecting. LED 1 of the PowerDock charger should illuminate yellow, which means that power is connected to the charger.

Note – The power supply unit and the PowerDock charger are not for outdoor use. To avoid electrical shock, use them in dry indoor environments only.

3. Point the battery's contacts to the PowerDock charger and place the battery flat along the arrow mark on the charger and slide it carefully into charging position until it snaps into place. Make sure that the battery's pins are in contact with the charger's terminals.



4. Charging starts automatically as soon as the battery has been inserted into the charger; LEDs 2 to 5 blink and illuminate according to the current charging state of the battery. For more information, see [PowerDock battery charger cradle, page 30](#).
5. After charging, carefully slide the battery out of position and remove it.

Setting up the tripod

Extend and lock all legs of the tripod. Check that the tripod adjustment arrangements have been locked and that the legs are of even length. Ensure that the surface is stable, that the tripod feet are secured and that it is firm in its position. The tripod's plate should be levelled as horizontally as possible.

In extreme windy conditions, please make sure that the tripod has a stable standing. For this, you should affix a heavy weight to the tripod or sandbag its feet.

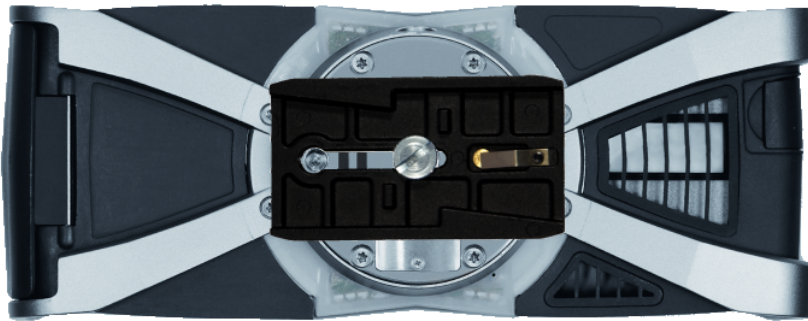
The Gitzo carbon fiber tripod, shown below, is an optional accessory.



Mounting the laser scanner

To mount the laser scanner to a tripod we recommend using a standard photo camera quick release. The quick release's plate must be equipped with a 3/8" screw to fit into the scanner's mount.

1. Remove the laser scanner from the case, check outer casing for any signs of damage or distortion. Check mirror for damage due to scratches, cracks, distortion and inspect for cleanliness.
2. Attach the quick release's plate with its 3/8" screw to the scanner's mount. Make sure to tighten the screw.



3. Mount the counter piece of the quick release onto the tripod. Make sure that it is fixed securely.
4. Carefully mount the laser scanner with the attached quick release plate to its counter piece and lock its fastener. Test that the scanner is correctly locked in place by gently attempting to lift it from the tripod.
5. The scanner should be set up as horizontally as possible. The levelling may be refined using the integrated dual axis compensator. See [Inclinometer \(Dual Axis Compensator\)](#), page 90.

Please see the user manual of your quick release for detailed instructions.

Using an SD memory card

Preparing an SD memory card

The laser scanner will store the recorded scans on a removable SD memory card. This memory card can also be used to create backups of the scanner settings, to import scanner settings and to install firmware updates.

Before carrying out a scan project you may use TX5 SCENE software to set up an SD card with project relevant information and settings, like the project structure, scan profiles or scanner operators. These settings can then be transferred to the scanner. For more information on scan project preparation with TX5 SCENE software and transferring data to the scanner, see [SD Card, page 84](#) and also refer to the *Trimble TX5 SCENE Software User Guide*.

You can use SD, SDHC or SDXC cards. Memory cards with a size up to 64 GB have been verified to operate with the scanner. We recommend using memory cards with a capacity of 4 GB or more. The speed of the card should be Class 6 or better and its temperature range should be from -20°C (-4°F) to 85°C (185°F).

Note – All used SD cards must be formatted in the FAT32 file system. When using an SD card other than the supplied one, please format it with the scanner's format function first. For more information, see [SD Card, page 84](#).

SD and SDHC cards may also be formatted with Windows as FAT32. SDXC cards with a capacity of more than 32GB cannot be formatted with the Windows format function as Windows formats those cards in its own file system, which is not supported by the scanner. Freeware tools that allow formatting such cards with Windows as FAT32 are available, but Trimble recommends using the scanner's format function.



CAUTION – Do not remove the SD card from the scanner while it is busy. A busy SD card is indicated by this icon



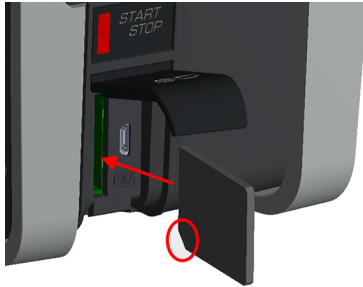
blinking in the status bar of the operating software.



CAUTION – When removing an SD card from your computer, you should always use the *Safely Remove Hardware* option from the system tray, otherwise you risk corrupting the data on the SD card.

For information on the folder and file structure of a memory card, see [File structure of the SD memory card, page 101](#).

Inserting the SD memory card



1. Open the SD memory card slot cover.
2. Insert the formatted SD card with the notched edge in the direction as illustrated until it clicks.
3. Confirm the direction of the memory card. If you forcibly insert the memory card in a wrong direction, the SD card, the card slot or data on the card can be damaged.
4. Close the cover.

Ejecting the SD memory card

To remove a SD card from the scanner, open the SD card slot cover and lightly push the memory card.

- Do not eject the memory card during scanning or firmware updates.
- Take care that the memory card does not pop out and drop.

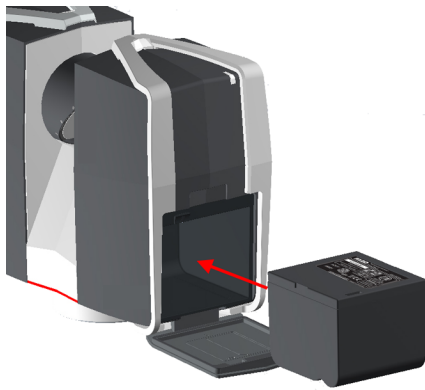
Powering the laser scanner

The laser scanner can be operated with the battery and the external power supply unit.

Supplying power with the battery

Adhere to the battery safety measures (see [PowerBlock battery safety, page 14](#)) and mount a charged battery into the laser scanner:

1. Open the scanner's battery compartment cover.
2. Turn the battery so that its type label is directed upwards, point the battery contacts to the scanner, push the battery straight in, and slide it downward into the battery compartment until the fastener clicks into position.



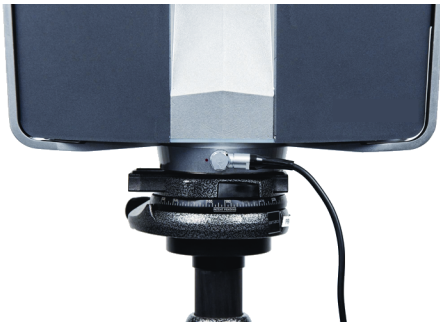
3. Close the battery cover.

Supplying power with the external power supply unit

1. Attach the power supply to one of the tripod's legs.



2. Connect the power supply unit cable to the power socket of the laser scanner. Confirm the direction of the power supply's plug. If you forcibly insert the plug in a wrong direction, the plug, the scanner's power socket, as well as the scanner can be damaged.



3. Connect the AC power cable to the power supply as well as to a power outlet. Check the input voltage on the type label before connecting. The upper LEDs of the scanner on the mirror and sensor side as well as the LED of the scanner mount begin to illuminate yellow.

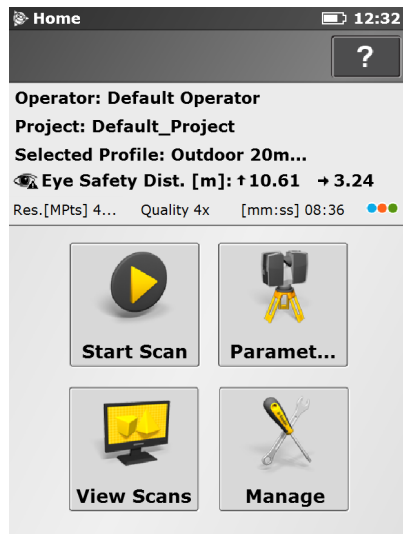
Note – *To avoid electrical shock, outdoor use of the power supply unit is not permitted. Use the power supply unit in dry indoor environments only.*

Powering on the laser scanner

Pressing the scanner's **Power** button will start the boot process, which will be indicated by the scanner LEDs blinking yellow.

If power is supplied by the battery only and its charge state is too low to start the scanner, the scanner LEDs will blink orange.

When the laser scanner is ready, the LEDs stop blinking and illuminate yellow and the *Home* screen of the scanner's operating software will appear on the integrated touch screen.



The laser scanner can be operated to its full extent by simply touching the elements on the screen with your fingers. You can also use a stylus, if you prefer.

Initial scanner settings

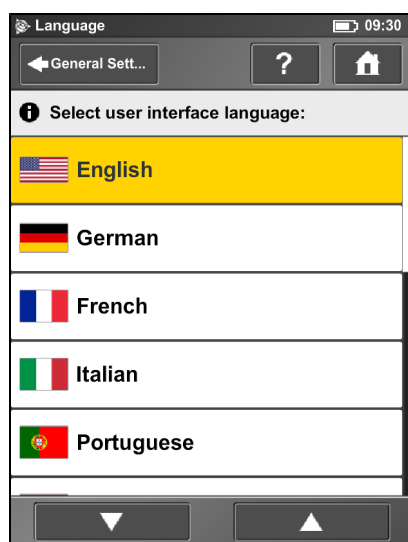
This section gives you a brief description on how to set up initial scanner settings using the scanner's operating software on the integrated touch screen:

- [Setting the interface language, page 42](#)
- [Setting the date and time, page 43](#)
- [Setting the date format, page 43](#)
- [Changing the date and time, page 44](#)
- [Setting the unit of length and the temperature scale, page 45](#)
- [Entering scanner information, page 45](#)

For more information, see [TX5 Controller Software, page 60](#).

Setting the interface language

Starting from the *Home* screen, go to *Manage / General Settings / Language* to change the language of the operating software.

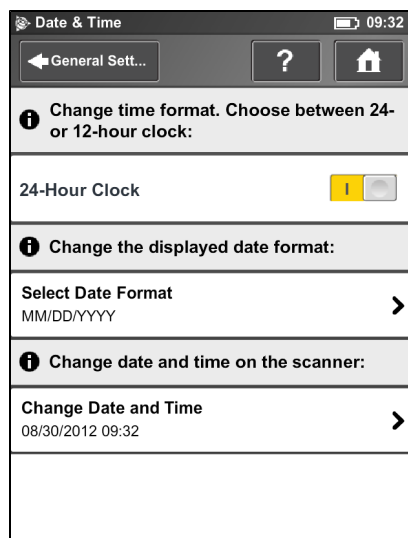


To set the language, tap the language in the list. The selected language is highlighted.

If the list of available languages exceeds the screen size, scroll the list up or down using the **arrow buttons**.

Setting the date and time

To change the date and time settings, go to *Manage / General Settings / Date & Time*.

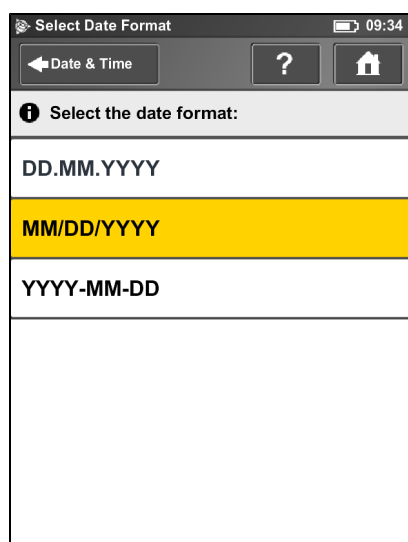


Time Format – Tap to set the time format. The operating software shows the time in 24-hour or 12-hour format. Switch the button to ON to select the 24-hour clock. Switch the button to OFF to select the 12-hour clock.

Selected date format – Tap to choose the date format. The currently selected date format is displayed on the button itself.

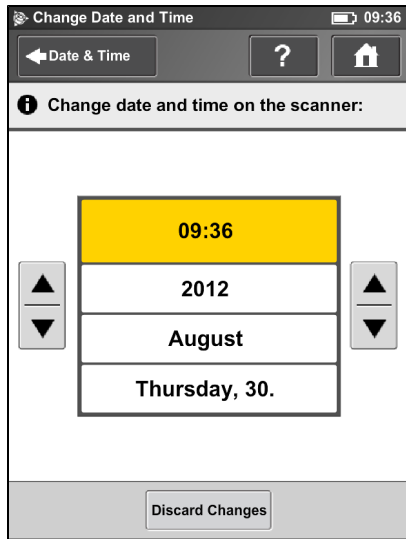
Change date and time – Tap to set the internal clock of the laser scanner.

Setting the date format



To select the date format, tap the format in the list. YYYY is the year, DD the day and MM the month. The selected format is highlighted.

Changing the date and time



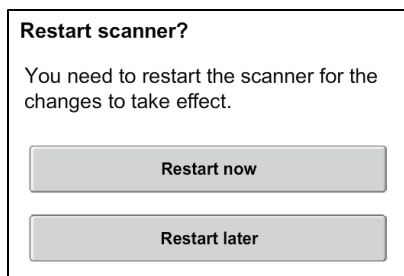
Select the **Time** button in the list to change the time, then use the buttons on the left to set the hours, the buttons on the right to set the minutes.

Select the **Year** button in the list to change the year, then use the buttons on the left or on the right to set the date.

Proceed accordingly with the **Month** and the **Day** buttons.

Click **Discard Changes** to discard your changes.

To apply your changes, leave the screen using the **Back** or **Home** button. A message warns if you need to restart the scanner for the changes to take effect.



Setting the unit of length and the temperature scale

You can change the units scale under *Manage / General Settings / Units*.

Lengths are displayed in meters or in feet. Tap a unit of length to select it.

Temperatures are displayed in Celsius or Fahrenheit. Tap a temperature scale to select it.

Entering scanner information

To specify a scanner name and the owner, go to *Manage / General Settings / Scanner Details*.

Scanner name – Tap to change the name of the scanner.

Owner – Tap to enter the name of the company or person who owns the scanner. For more information, see [Scanner Details, page 81](#).

Scanning

This section provides a brief description on how to change the scanning settings so that you can capture your first scans.

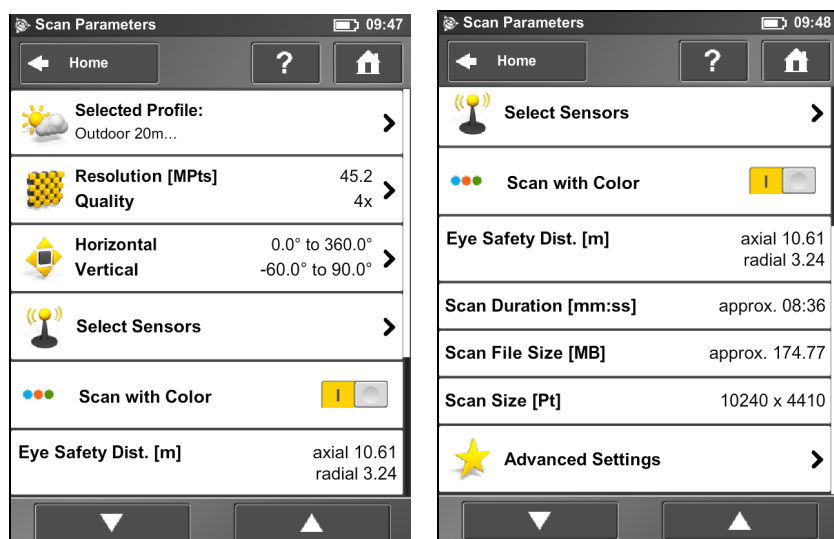
- [Setting the scan parameters, page 46](#)
- [Scanning parameters overview, page 51](#)
- [Enhancing the scanning environment with artificial targets, page 53](#)
- [Environmental conditions, page 55](#)
- [Starting a scan, page 55](#)

For more information, see [TX5 Controller Software, page 60](#).

Setting the scan parameters

Scanning parameters like resolution, quality or the scanning angles are the parameters used by the scanner for recording the scan data. There are two ways to set the scanning parameters: Change them manually or select a scan profile which is a predefined set of scanning parameters. When selecting a scan profile, the scanning parameters will be overwritten by the settings of this scan profile.

To choose a predefined scan profile or to change the scanning parameters manually tap the **Parameters** button on the *Home* screen.



Selected Profile – Shows the name of the selected scan profile. Tap to select a scan profile. If the scanning parameters differ from the selected profile, **altered** is appended to its name. Selecting a scan profile overwrites the scanning parameters with the settings of this scan profile.

Resolution and Quality – Displays the selected resolution in Mega points and the selected quality. Tap to change these values.

Horizontal and Vertical Scan Range – Displays the scan range with the horizontal and the vertical start and end angles in degrees. Tap to adjust them.

Select Sensors – Tap to enable or disable the automatic use of data from the built-in sensors for scan registration in TX5 SCENE software.

Note – *The available sensors vary depending on the scanner model.*

Scan with Color – Switch colored scan recording on or off.

Advanced Settings – Enable or disable the Clear Contour and Clear Sky filters.

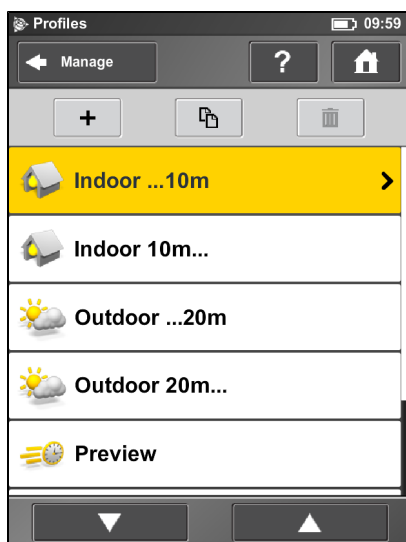
Eye Safety Distance – The axial and radial eye safety distance (NOHD). Both values depend on the selected resolution and quality setting. For more information, see [Laser safety, page 16](#).

Scan Size [Pt] – Shows the size of the scan in points horizontally x vertically. The vertical size may only be changed by setting a new resolution or by changing the scan area angle.

Scan Duration, Scan File Size – Expected scan time and file size in Megabytes according to the chosen resolution, quality value, and scan range. The values shown here are approximate values.

Selecting a scan profile

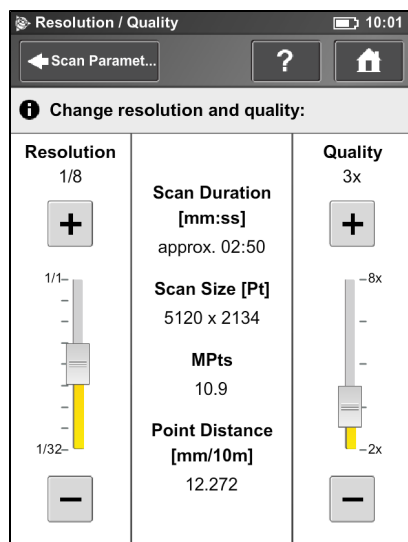
Prior to capturing a scan, you may select a scan profile that fits the needs of the scene and the desired scan quality.



This view shows a list of all available scan profiles. This list contains factory predefined profiles which are read-only and custom profiles which can be created and manipulated under **Manage Profiles**. For more information, see [Creating a scan profile, page 71](#).

Tap a profile to select it. The selected profile is highlighted. To view the details of the selected profile, tap it again.

Setting resolution and quality



Resolution – The resulting scan resolution. You can choose among 1/1, 1/2, 1/4, 1/5, 1/8, 1/10, 1/16, 1/20 and 1/32. Use the slider on the left to change the resolution of the next scan.

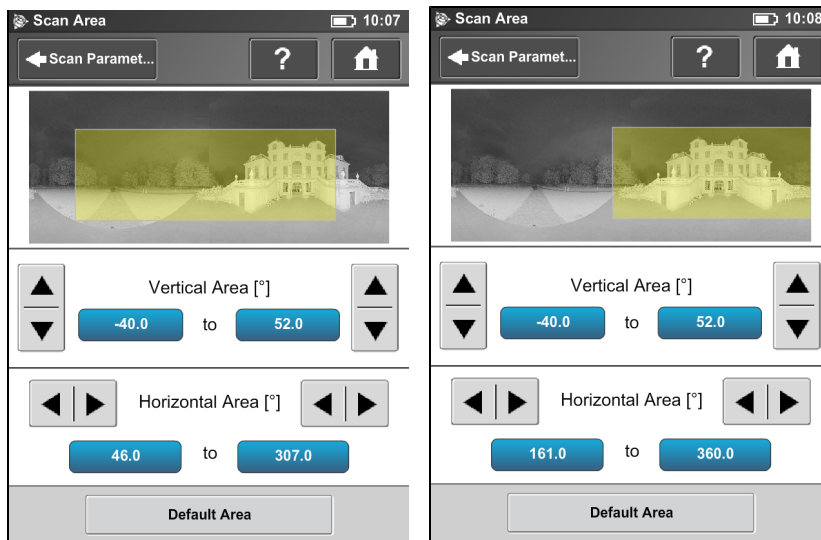
Quality – Affects the quality of the scan and the scanning time at constant scan resolutions. Move the slider up to reduce the noise in the scan data and increases the scan quality. This results in a longer scanning time. Move the slider down to reduce the scanning time and increase the efficiency of your scan project. The Quality slider sets quality levels either via diverse measurement rates or by applying additional noise compression. For more information, see [Scanning parameters overview, page 51](#).

The resulting *scan duration*, vertical and horizontal scan points (*Scan Size [Pt]*), as well as the resulting scan size in Mega points (*MPts*) are displayed in the middle of the view. *Point Distance [mm/10m] / [in/30ft]* is the distance between the captured scan points in mm (in) in a scan distance of 10 meters (30 ft.).

Depending on the chosen scan resolution only appropriate quality values are selectable (see [Scanning parameters overview, page 51](#)).

If you plan to capture several scans from the same position (with different resolutions) and if it is important that these scans have the same horizontal start angle, then you should **not** switch off the scanner or change the quality between the recordings of these scans.

Setting the scan range



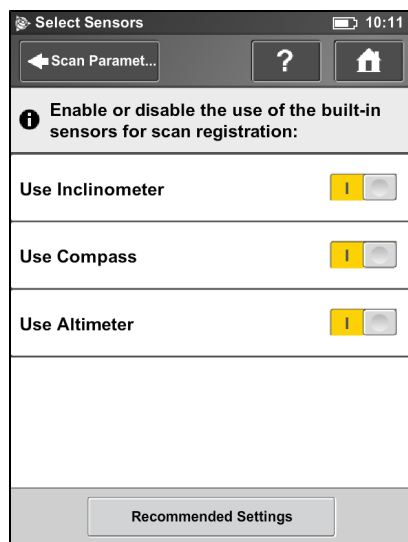
Vertical area – The size of the vertical scan area in degrees. Use the left up and down buttons to change the vertical start angle. Use the right up and down buttons to adjust the vertical end angles.

Horizontal area – The size of the horizontal scan area in degrees. Use the left buttons to change the horizontal start angle. Use the right buttons to adjust the horizontal end angles.

Default Area button – Tap to reset the values to the default scan area (vertical from -60° to 90° and horizontal from 0° to 360°).

The rectangle in this view illustrates the full scan area. If there are scans on the inserted SD card, the preview picture of the last recorded scan is displayed. If there is no preview picture available, a grid is displayed, where the space between the horizontal and vertical lines is equivalent to 30°. The yellow rectangle illustrates the selected scan area.

Selecting the sensors



Use Inclinometer – Enable or disable the automatic use of the inclination measurement of the built-in dual axis compensator (inclinometer) for scan registration in TX5 SCENE software. However, the data of this sensor is always measured and attached to each scan. If the use of the inclinometer data is switched ON, it is automatically used to register the scans in TX5 SCENE software; if it is switched off, the data is ignored. You can change this behavior later in the TX5 SCENE software. For more information, refer to the *Trimble TX5 SCENE Software User Guide*.

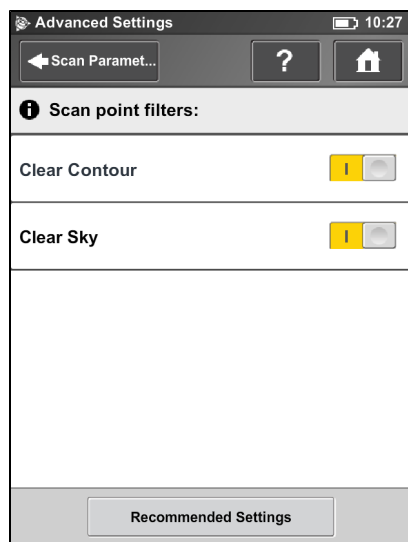
Note – To get the most reliable data from the dual axis compensator, make sure that the scanner's inclination is less than 5°. For more information, see [Inclinometer \(Dual Axis Compensator\)](#), page 90.

Use Compass – Enable or disable the automatic use of data from the built-in compass for scan registration in TX5 SCENE software. The data of the compass is always measured and attached to each scan during scanning. If this button is switched to ON the data is automatically used for scan registration. For more information, see [Compass](#), page 91.

Use Altimeter – Enable or disable the automatic use of altimeter data for scan registration in TX5 SCENE software. The data of the altimeter is always measured and attached to each scan during scanning. If this button is switched to ON the data is automatically used for scan registration. You may want to enter a reference height before starting your scan project. This reference height then acts as basis for all measurements made by the altimeter. Altimeter settings are in *Manage / Sensors / Altimeter*. For more information, see [Altimeter](#), page 92.

Click the **Recommended Settings** button to enable the use of all sensors.

Advanced Settings



Clear Contour – Enables the dynamic contour filter. While scanning, this hardware filter removes incorrect measurements at the edges of objects. It removes scan points resulting from hitting two objects with the laser spot which mainly happens at the edges of objects.

Clear Sky – Enables the dynamic sky filter. While scanning, this hardware filter removes scan points resulting from hitting no objects at all which mainly happens when scanning the sky.

Recommended Settings button – Enables both filters.

Scanning parameters overview

The table below shows the measurement speed, noise compression, net scan time, and the axial and radial NOHD for all the resolution and quality settings that are available.

Note – The scan duration shown in the Scan Parameters screen and the scan duration values shown below view differ from each other, because the values shown below are pure net values and the time needed for capturing photos in color mode and pre and post processing time are not taken into account.

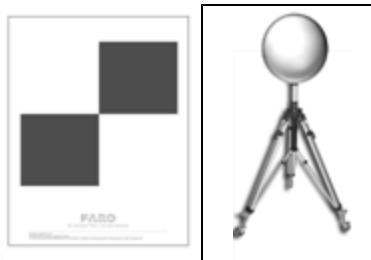
Resolution Mio. Pts (full scan)		Quality	Speed (kpt/sec)	Noise compression	Net scan time (full scan)	pt/360°	NOHD [m]	
							axial	radial
710.7	1/1	1x	976	—	0:14:19	40,960	7.50	3.60
710.7	1/1	2x	488	—	0:28:38	40,960	12.50	6.30
710.7	1/1	3x	244	—	0:57:16	40,960	20.30	10.90
710.7	1/1	4x	122	—	1:54:32	40,960	29.40	16.20

Resolution		Quality	Speed (kpt/sec)	Noise compression	Net scan time (full scan)	pt/360°	NOHD [m]	
Mio. Pts (full scan)							axial	radial
177.7	1/2	1x	976	—	0:03:35	20,480	4.50	1.80
177.7	1/2	2x	488	—	0:07:09	20,480	7.50	3.20
177.7	1/2	3x	244	—	0:14:19	20,480	12.50	5.50
177.7	1/2	4x	122	—	0:28:38	20,480	20.30	8.30
177.7	1/2	6x	122	2x	1:54:32	20,480	29.40	16.20
44.4	1/4	1x	976	—	0:00:54	10,240	2.70	0.30
44.4	1/4	2x	488	—	0:01:47	10,240	4.50	1.60
44.4	1/4	3x	244	—	0:03:35	10,240	7.50	2.80
44.4	1/4	4x	122	—	0:07:09	10,240	12.50	4.20
44.4	1/4	6x	122	2x	0:28:38	10,240	20.30	8.30
44.4	1/4	8x	122	4x	1:54:32	10,240	29.40	16.20
28.4	1/5	2x	488	—	0:01:09	8,192	3.80	1.30
28.4	1/5	3x	244	—	0:02:17	8,192	6.30	2.20
28.4	1/5	4x	122	—	0:04:35	8,192	10.60	3.30
28.4	1/5	6x	122	2x	0:18:20	8,192	20.30	8.30
11.1	1/8	2x	488	—	0:00:27	5,120	2.70	0.20
11.1	1/8	3x	244	—	0:00:54	5,120	4.50	1.40
11.1	1/8	4x	122	—	0:01:47	5,120	7.50	2.10
11.1	1/8	6x	122	2x	0:07:09	5,120	12.50	4.20
11.1	1/8	8x	122	4x	0:28:38	5,120	20.30	8.30
7.1	1/10	3x	244	—	0:00:34	4,096	3.80	0.70
7.1	1/10	4x	122	—	0:01:09	4,096	6.30	1.70
7.1	1/10	6x	122	2x	0:04:35	4,096	10.60	3.30
7.1	1/10	8x	122	2x	0:18:20	4,096	20.30	8.30
2.8	1/16	3x	244	—	0:00:13	2,560	2.70	0.10
2.8	1/16	4x	122	—	0:00:27	2,560	4.50	0.90
2.8	1/16	6x	122	2x	0:01:47	2,560	7.50	2.10
2.8	1/16	8x	122	4x	0:07:09	2,560	12.50	4.20
1.8	1/20	4x	122	—	0:00:17	2,048	3.80	0.40
1.8	1/20	6x	122	2x	0:01:09	2,048	6.30	1.70

Resolution	Quality	Speed (kpt/sec)	Noise compression	Net scan time (full scan)	pt/360°	NOHD [m]	
Mio. Pts (full scan)						axial	radial
1.8	1/20	8x	122	4x	0:04:35	2,048	10.60 3.30
0.7	1/32	4x	122	—	0:00:07	1,280	2.70 0.10
0.7	1/32	6x	122	2x	0:00:27	1,280	4.50 0.90
0.7	1/32	8x	122	4x	0:01:47	1,280	7.50 2.10

Enhancing the scanning environment with artificial targets

Before scanning, you should make sure that there will be enough reference objects in the scans so that there will be no problems during the later registration process. References, or targets, are used to register multiple individual scans that are each on their own coordinate system, onto a single, aligned coordinate system. Although scan registration using TX5 SCENE software can be done purely on the basis of natural targets, such as planes, walls, corners etc., we recommend to enhance the scanned environment with additional artificial reference objects, like spheres or checkerboard paper targets. Spheres and paper targets can be combined within a scan site. Usually you will achieve more precise registration results when you have manually placed such targets.



The following tips and hints provide an overview of basic principles which should be obeyed when working with artificial reference objects like spheres or paper targets.

General

- Mathematically you need three corresponding references in the two scans which you like to register to each other. The inclination data captured by the built-in dual axis compensator may serve well as one reference, such that only 2 other scanner external references are required. But a higher number of references per scan may improve the registration results and may make registration easier and less error prone.
- As artificial targets you should use checkerboard targets or reference spheres.
- Use targets with a non-reflecting surface.
- Print paper references with laser printers only.
- The references should be easily and clearly visible in the scans.

- Targets should not be positioned symmetrically. They should form a polygon around the scanner and have varying distances to the scanner. Place them in the scanning area at varying heights, distances and planes. Avoid placing the targets in a straight line.
- If the references cannot be placed in an adequate distance to the scanner, increase the scanning resolution or the size of the targets.
- Do not place targets in close proximity to one another. The distance between targets should not be smaller than 1m.
- Make sure you see the targets in more than one scan (if you do not have surveyed coordinates for each targets). A target which is only visible in one scan is useless for registration.
- When capturing a chain of scans resulting in a tubular point cloud which is typical for e.g. tunnel surveying, it is recommended to make use of the inclination sensor and references with surveyed coordinates. Such references should be used along the entire chain. The scanner has a certain measuring uncertainty and if you do not use surveyed references when capturing and registering a chain of scans, this measuring uncertainty may propagate from scan to scan.

Checkerboard Targets

- The angle of incidence between the laser beam and checkerboard targets should not be smaller than 45°.
- Depending on the chosen scanning resolution, the detection of checkerboard references in the scans by the TX5 SCENE software may be unreliable beyond a certain distance to the scanner. For example, when using A4 checkerboard references and scanning with a resolution of 1/4, the distance to the scanner should not be greater than 15m. Larger distances can easily be achieved by enlarging the size of the target or scanning with a higher resolution.
- Checkerboard targets should not be rotated by 45° in relation to the scanner's axis.
- Have sufficient scan points on the checkerboard targets. They need four or more scan points per quadrant.
- Checkerboard targets should not be attached to a curved surface.

Reference Spheres

- Reference spheres should be completely visible in the scan. Make sure that they are not partly covered by other objects.
- Depending on the chosen scanning resolution, the detection of sphere references by the TX5 SCENE software may be unreliable beyond a certain distance to the scanner. For example, when scanning with a resolution of 1/4 and using spheres with a diameter of 145mm, the distance to the scanner should not be greater than 18m. If you are using larger spheres, for example spheres with a diameter of 200mm, the distance to the scanner may be extended to 45m.

For more information on registering scans and using references for registration, refer to the *Trimble TX5 SCENE Software User Guide*.

Environmental conditions

- When the product is transferred from a cold to a significantly warmer environment, water may condense on some elements inside the scanner. To avoid this, we recommend placing the scanner in an airtight plastic bag before bringing it from a cold to a significantly warmer environment. This allows the condensation to form on the bag and not inside the scanner. If you do not have the possibility to pack the scanner airtight, please wait until observable condensation water evaporates from the scanner before switching on the laser scanner.
- For applications requiring the highest degree of accuracy such as reverse engineering and starting with the scanner at lower temperatures, it is advised to turn the scanner on and warm it up until the internal temperature stabilizes.
- If the temperature of the scanner is above or below the specified range, you will get a warning. Scanning is still possible but the temperature may have impact on the measuring accuracy. If an upper or lower temperature limit is exceeded, the scanner will automatically shut down to avoid damages.
- Strong dust formation, fog, rain or snowfall may result in bad measurements. You should avoid scanning under these conditions.
- You should avoid scanning objects against direct sunlight. This may result in limited scan data in this area.
- Objects or surfaces may have an increased range noise if they are directly illuminated by bright sunshine.
- Highly absorbing or highly reflective surfaces increase the range noise and thus the measuring inaccuracy. If these surfaces are of importance, you should treat them, for example with developer or anti-glare-spray.

Starting a scan

If you are in a distance less than the eye safety distance (NOHD), respect the laser safety measures described in the laser scanner manual and in the appropriate national and regional regulation and work place safety legislation.

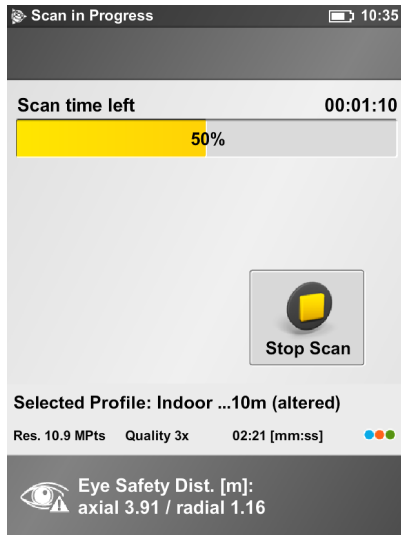
If you are in a distance less than the eye safety distance (NOHD), respect the laser safety measures described in [Laser safety \(page 16\)](#) and in the appropriate national and regional regulation and work place safety legislation.

Remember that the scanner is turning and the mirror unit is rotating with high speed. Ensure that the scanner can move freely and that no objects can touch the mirror unit.

You can start your scan either by clicking on the **Start Scan** button on the *Home* screen of the operating software or by pressing the **Start / Stop** button on the scanner.

If there is not enough space on the SD memory card, you will be warned and the scanner will refuse scanning. In this case, please remove scan data from the memory card or insert a new card and try again.

The scan process starts, the laser of the scanner will be switched ON and the scanning view will be displayed. The scanner's LEDs are blinking red as long as the laser of the scanner is switched ON. During scanning, the scanner rotates clockwise by 180°. If you are scanning with color, the scanner will continue to turn to 360° to take the pictures. The executed processing steps are displayed in the status bar of the scanning screen, the scan progress is indicated by the progress bar.

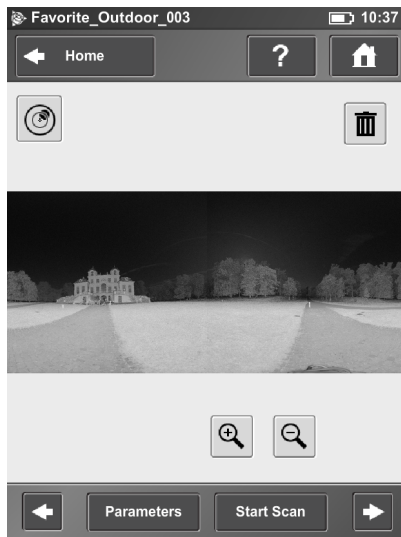


To stop a scan touch the **Stop Scan** button in the scanning view or press the **Start / Stop** button on the scanner. You will then be asked to keep or delete the incomplete scan.



Caution – After having completed scanning and capturing the pictures, depending on environmental conditions, the scanner may make another full turn to capture inclination data. It is important NOT to move the scanner while it is capturing the inclination data. Else, the inclination data of the scan may be inaccurate and may not be usable for the scan registration.

As soon as the entire scanning process is complete, the scanner plays a notification sound (if not turned off in the settings) and a new screen appears with a preview picture of the captured scan. Now, you may move the scanner to the next scan position and start a new scan.





The scan preview shows a grayscale picture of the captured scan to verify the scan itself and to check if all objects (e.g. targets) are clearly visible. This preview does not show color.


Parameters button – Change the scanning parameters for the next scans.


Start Scan button – Starts the next scan.

Delete button  – deletes the viewed scan file.

Use the **Left**  and **Right**  **arrow** buttons to browse through already captured scans.

Use the **Plus**  and **Minus**  buttons to zoom in or out.

The **Reset Zoom** button  is only visible when you zoom into the scan picture. With this button the scan picture can be zoomed back to its original size. When zoomed in you can move the zoomed picture by dragging it with your fingers in any direction.

The **Inclination Warning** button  is only visible when the current inclination of the scanner is above 5°. To get reliable measurements from the built-in dual axis compensator you should set up the scanner with an inclination less than 5° before starting your next scan. For this, you may use either a bubble inclinometer at the tripod or the inclinometer screen. Click this button to get to the inclinometer screen. For more information, see [Inclinometer \(Dual Axis Compensator\)](#), page 90.

Shutting down the laser scanner

To shut down the laser scanner, shortly press the **Power** button or use the shutdown button in the operating software under *Manage*. All LEDs will start blinking yellow. As soon as the laser scanner has finished the shutdown process the LEDs will stop blinking and you can safely remove the battery and the power supply.

DO NOT turn off the power of the laser scanner before the shut down cycle is complete. The laser scanner has a PC with an integrated hard drive. This internal PC must be shut down before turning off the power supply. If the power supply is disconnected or switched off without the laser scanner being previously shut down, it may damage the internal PC and might lead to a loss of data.

Pressing and holding the button more than 10 seconds will switch the laser scanner off without shutting down. Only if the laser scanner does not shut down normally because of a malfunction.

Note – *If the laser scanner has not been shut down properly, the next boot process could take more time than usual as the laser scanner checks the hard disk for errors. Some settings, which were made shortly before shutting down the laser scanner, might also be lost.*

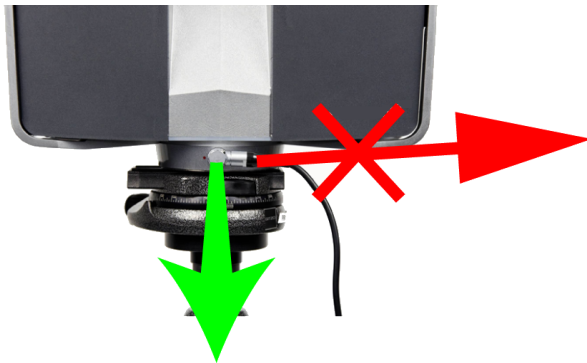
Powering off the laser scanner

Once the laser scanner has been completely shut down, disconnect the AC power cable first, then disconnect the power supply cable from the laser scanner, remove the battery and secure the equipment in protective cases.

Removing the battery

1. Open the battery cover.
2. Push the fastener to release the battery.
3. Remove the battery.
4. Close the battery cover.

Unplugging the power supply



Take care to unplug the bend connector from the laser scanner by pulling at the connector only! Do not pull at the cable or you may damage the connector and the laser scanner!

TX5 Controller Software

In this chapter:

- [General elements](#)
- [Home screen](#)
- [Manage screen](#)
- [View scans](#)
- [Online help](#)

This chapter provides information about the TX5 Controller software, used to operate the laser scanner.

General elements

Status bar



- ① Current view – The name of the currently active and visible screen on the display.
- ② Battery icon – shows the status and charge state of the internal battery.
- ③ Clock – shows the current time of the laser scanner. See [Setting the date and time, page 43](#) for information on how to change the date and time of the scanner.






Symbols used for the battery status are:

Icon	Meaning
	Battery is fully charged
	Charge state between 75 and 100%
	Charge state between 50 and 75%
	Charge state between 25 and 50%
	Charge state between 10% and 25 percent. You should recharge the battery or connect the power supply.
	Battery is almost empty; the laser scanner will automatically shut down within the next minutes.
	Battery is charging.
	No battery in the laser scanner.

The exact charge state of the battery can be viewed under *Manage / General Settings / Power Management* (see [Power Management, page 77](#)).

If the charge state of the battery is below 25 percent you will get a warning. In this case please use a spare battery and/or connect the power supply to the laser scanner. If the charge state of the battery reaches 10 percent the laser scanner will stop scanning and will automatically shut down.

Further situational icons of the status bar:











Icon	Meaning
	SD Card is busy. Do not remove the card from the scanner while it is busy.
	No SD card inserted.
	SD card is write protected. Remove write protection to be able to scan.
	Unknown SD card inserted. The card cannot be read. This might be due to the SD card being formatted in an unsupported file system. Format the SD card with the built-in format function. For more information, see SD Card, page 84 .
	WLAN is turned on.

Navigation bar



- ① **Back** button – returns you to the previous screen.
- ② **Errors and Warnings** button – this button only appears if warning or errors are present. Pressing the button opens a screen that informs about details of the existent warnings or errors. See [Errors and Warnings, page 83](#).
- ③ **Help** button – opens the online help of the currently active screen and provides access to the laser scanner video guide. See [Online help, page 97](#).
- ④ **Home** button – returns you to the *Home* screen. See [Home screen, page 65](#).

Frequently used buttons

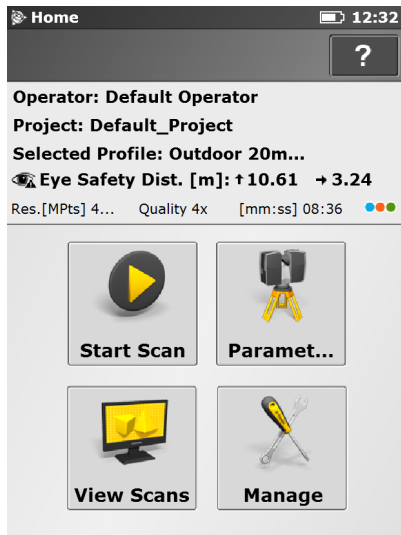
Icon	Meaning
	Add button. Adds new scan profiles, projects or operators.
	Duplicate button. Adds new scan profiles, projects or operators by duplicating the selected list element.
	Delete button. Deletes selected list elements, like projects, scan profiles or operators.
	Disabled Delete button. The selected list element can not be deleted.
	Scroll up and down buttons. Appear on the bottom of the screen if the content of a screen exceeds the screen height. Press the button to scroll the screen up or down.
	An arrow on a list item indicates that you tap it to open a new screen with further details or settings.
	A highlighted field indicates that the list item is currently selected and active.
	Highlighted list items indicate that the item is currently selected and that further details and settings are available by tapping the list item once again
	Check box. Used to turn functions on or off. Here, the function is turned on
	Check box. Used to turn functions on or off. Here, the function is turned off.

Onscreen keyboard



- ① Shift key to toggle between capital and lower case letters.
- ② Key to toggle keyboard between standard and special characters.
- ③ Moves the cursor in the text field right or left.
- ④ Tap a key to enlarge it and its neighboring keys. Choose between the enlarged keys by dragging the finger a bit to the right or to the left. The selected key is highlighted.
- ⑤ Delete key – deletes the complete text.
- ⑥ Backspace
- ⑦ **Cancel** button – returns to the previous screen without applying your changes.
- ⑧ **OK** button – applies your input and returns to the previous screen.

Home screen



Start Scan button – Starts a scan. See [Starting a scan, page 55](#).

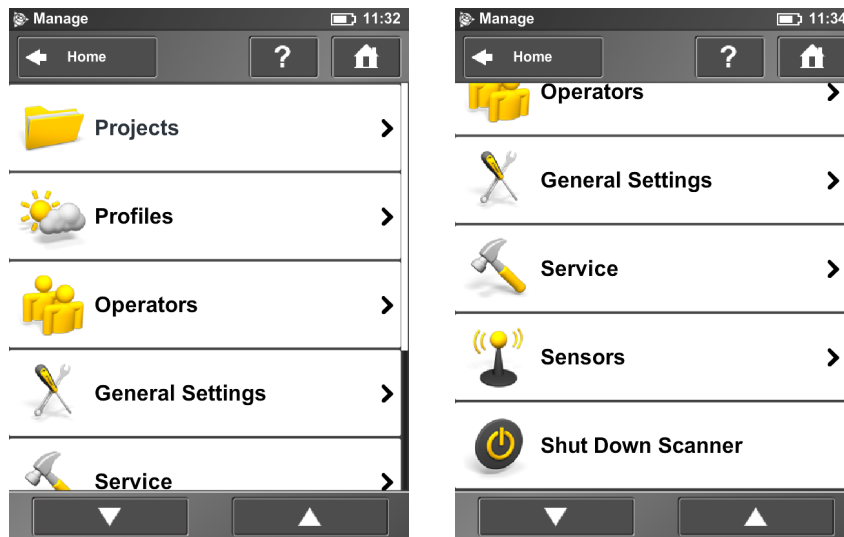
Parameters button – Opens the dialog to select another scan profile and to edit the current scanning parameters. See [Setting the scan parameters, page 46](#).

View Scans button – Preview the scans that are stored on the SD card. See [View scans, page 94](#).

Manage button – Manage scan profiles, projects, operators and the scanner. See [Manage screen, page 66](#).

The information box shows the currently selected operator, project and scan profile, as well as information about the current scanning parameters (resolution in mega points, quality, scan duration and color) and the corresponding axial and radial eye safety distance.

Manage screen



Projects – Select the current scan project, add new or edit existing projects (see [Managing scan projects, page 67](#)). Tap to get a list of all available projects.

Profiles – Select the current scan profile, create new or edit existing scan profiles. See [Managing scan profiles, page 71](#).

Operators – Select the current scanner operator, create new or edit existing operators. See [Managing operators, page 73](#).

General Settings – Opens the menu of the general scanner settings. See [General settings, page 75](#).

Service – Opens the menu for scanner services, like firmware updates, backups or viewing errors and warnings. See [Service, page 82](#).

Sensors – Opens the menu for the scanner sensors administration. See [Sensors, page 89](#).

Shut down Scanner – Tap to shut down the scanner. See [Shutting down the laser scanner, page 58](#).

Managing scan projects

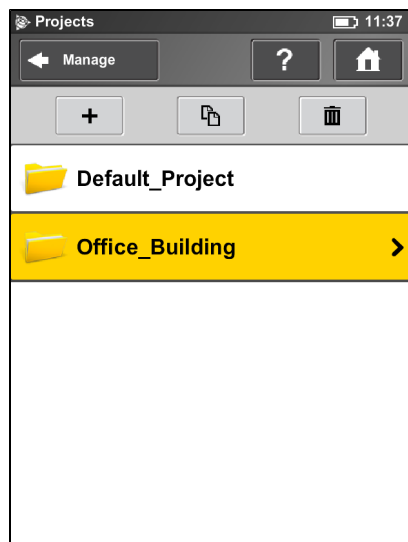
Projects in the operating software represent the structure of your real scan projects. A scan project usually consists of a main project that has several subprojects. For example, if you are scanning a multi-level building, each floor of this building might represent one subproject and each of these floors or subprojects might have further subprojects, for example rooms.

Before carrying out a scan project you should map its structure to the scanner's operating software. You can reproduce the complete structure of your scan project within the operating software of the scanner or, more convenient, with TX5 SCENE software and then transfer the project to the scanner via the SD card. For more information, refer to the *Trimble TX5 SCENE Software User Guide*.

Before starting a scan, you should select a scan project from the projects list that has been prepared by you in advance. This project should correspond to the current scan position. The next scan is then assigned to this project. This information will be attached to each scan, which is very helpful for the later registration of the scans and is used to automatically combine the scans to scan clusters.


Note – Every project and subproject gets a unique internal identification number when it is created. Combining the scans to scan clusters during postprocessing in TX5 SCENE software is done according to this identification number and not on the basis of the project name. This is particularly relevant when working with several scanners on the same scan project. In this case you should create the project (structure) once as a master and transfer it to all of your scanners. Avoid creating or editing a project of the same scan project separately on every scanner, because even if the separately created projects and subprojects are given the same name, they will have different identification numbers and will be treated as different projects by the TX5 SCENE software.


Creating a scan project




This view shows a list of all available scan projects.

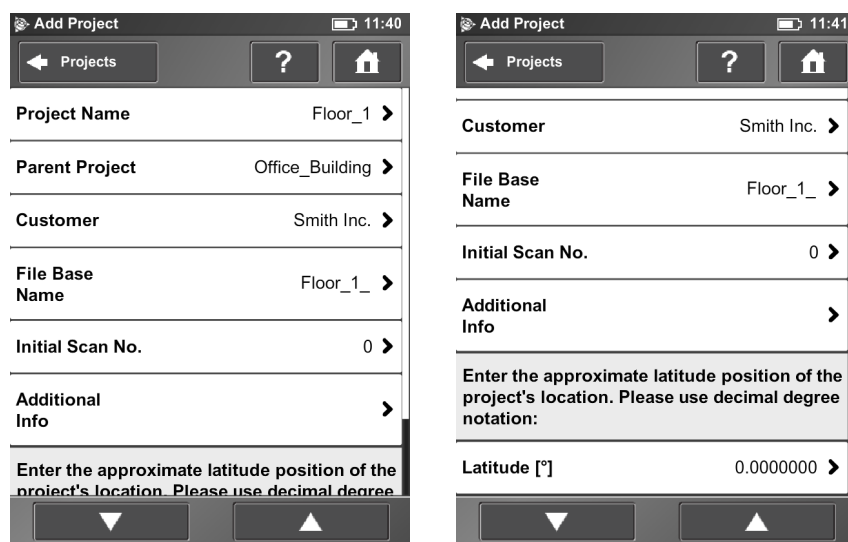
The "Default Project" is a standard project that may be selected when working in no particular scan project. The "Default Project" cannot be deleted and you cannot change its name or parent project.

To add a project, click the Add button . A new subproject is added to the selected project and the *View Project* screen appears. Here, you can change the name and enter further details of the new project. If you want the new project to be a main project without any parent projects, change its parent project to **no parent project** (see below for details) or you have to select the Default Project before adding the new project. With the Default Project selected, new projects are always added as a main project without parent projects.

Instead of adding a completely new project or subproject, you can also create new projects by duplicating existing ones. For this, select the project that you want to duplicate and click the Duplicate button . The newly created project has the same settings and properties as the original project.

To delete a project, select it in the list and click the Delete button . If the project has subprojects, they are also deleted.

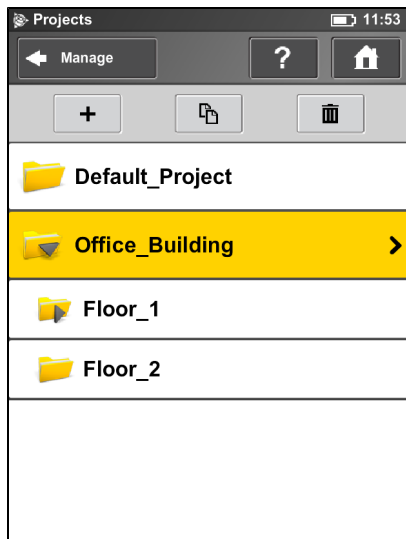
Projects are stored on the SD card. If you remove the SD card from the scanner, the entire structure of the currently selected project (all of its parent projects and their sub projects) as well as the Default Project remain on the scanner. All other projects are removed from the list, but remain on the SD card. If you insert a new SD card, the selected project, its parent and sub projects that are on the scanner are saved to the new SD card as soon as you make changes to it or as soon as a scan is started. If the new SD Card contains projects, they are added to the projects list.



The image shows two screenshots of the 'Add Project' screen. The left screenshot shows the 'Project Name' field with 'Floor_1' and 'Parent Project' with 'Office_Building'. The right screenshot shows the 'Customer' field with 'Smith Inc.' and 'File Base Name' with 'Floor_1_'. Both screens have a 'Projects' button at the top left and a 'Home' button at the top right. The bottom of both screens has a 'Latitude' field with '0.000000' and a 'Latitude [°]' label.

Project Name – The name of the project. Tap to change the name.

Parent Project – The parent project of the displayed project. No Parent Project means that the current project is a main project and not a subproject. Tap to change the parent project. A new screen appears with a list of all available parent projects. Tap a project to select it. The selected parent project is highlighted. The currently edited project becomes subproject of this project.



Customer – If you are carrying out the scan project by order of a company, you can enter its name here.

File Base Name – The scan will be saved with a file name consisting of this base name followed by the current scan number.

Initial Scan No. – Automatically increments with each successive scan. Can be reset and may be used to indicate the number of scans per scan session.

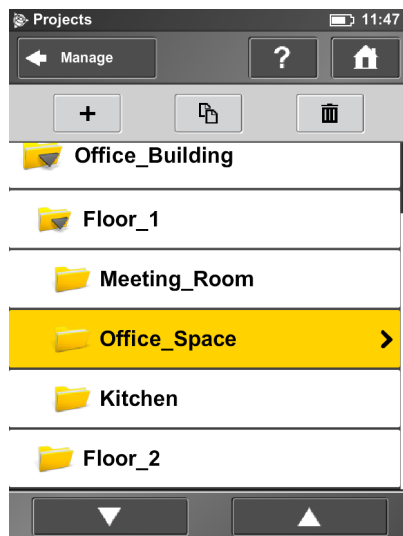
Additional Info – Additional project information.

Latitude [°] – If known, enter the approximate (+/- 10° is sufficient) latitude position of the scan project here. This information helps to improve the calibration of the inclination sensor and leads to more precise inclination data and thus to better scan registration results. Please enter the latitude value in decimal degree notation.

Editing a scan project

To edit a scan project, select it in the list and tap it once again to view the details screen.

Selecting a scan project






The project list contains the currently selected project and all further projects stored on the SD card.

To select a project, tap it in the list. The selected project is highlighted. To view or change details of the selected project, tap it again.

To display available subprojects of a project, select it and the list will be expanded with its sub projects. Proceed accordingly with further subprojects.

If the list of projects exceeds the screen size, scroll the list up or down with the buttons on the bottom.

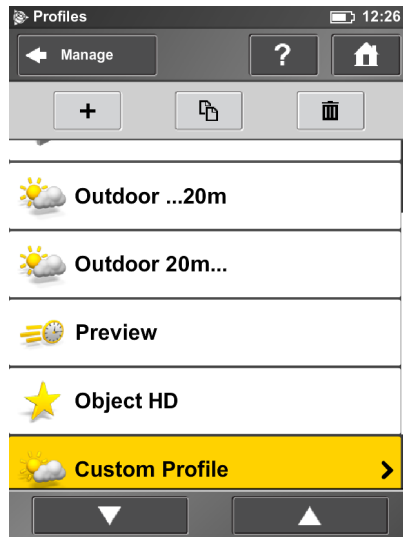
The icons on the projects are described below:

Icon	Description
	Project has no subprojects.
	Project has sub projects. Click to expand the list to view the sub projects.
	Project has sub projects. Its sub projects are currently shown (list is expanded accordingly).

Managing scan profiles



Selecting scan profiles to use their parameters for the next scan is described in [Setting the scan parameters \(page 46\)](#). This topic describes how to add new and how to edit existing scan profiles.


Creating a scan profile

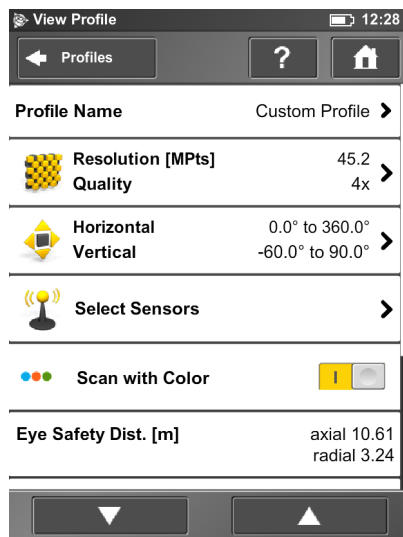


The laser scanner comes with predefined scan profiles. These scan profiles are read-only and cannot be changed or deleted. But you can add and manage your own custom scan profiles.

This view shows all scan profiles that are available on the scanner.

To add a new profile, click the Add button . You can also add new profiles by duplicating existing profiles. To do this, select the profile that you want to duplicate and click the Duplicate button . A new screen appears to enter the profile name and to adjust its scan parameters.

To delete a custom scan profile, select it and click the Delete button . You cannot delete predefined profiles.



Profile Name – Name of the scan profile. Tap to change it.

The further settings here are similar to the settings of the scanning parameters. For more information, see [Setting the scan parameters, page 46](#).

Editing a scan profile

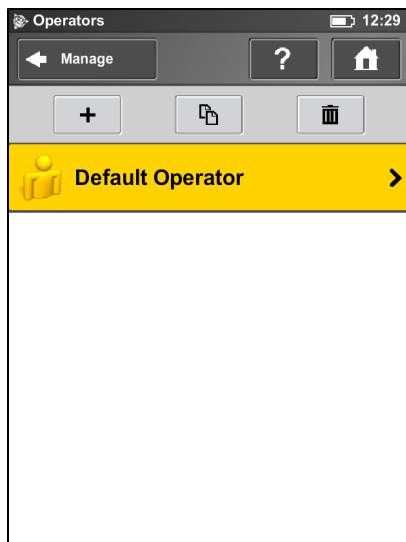
To edit a scan profile, select it in the list and tap it again to view its details. You cannot edit predefined profiles.

Managing operators

The information about which scanner operator has recorded which scans, can be useful for the person who is postprocessing the scans, especially when there are several scanner operators working on the same scan project.

You are able to assign scanner operators to the captured scans. To do this, select the operator in the operators list. You might have to create the operator first if it does not already exist. The name of the selected operator will then be stored in the metadata of the next scans and can be accessed in the TX5 SCENE software during scan postprocessing.

Creating an operator



To add a new operator, tap the Add button . Alternatively, tap an operator you want to duplicate and then tap the Duplicate button . The details screen for the new operator appears:

Name	Operator M. >
Company	Smith Inc. >
Department	Construction division >
Phone	555-0199 >
Email	operatorm@smithinc.com >
Info	scan operator >

Name – The name of the scanner operator.

Company – The name of the company providing the scanning service.

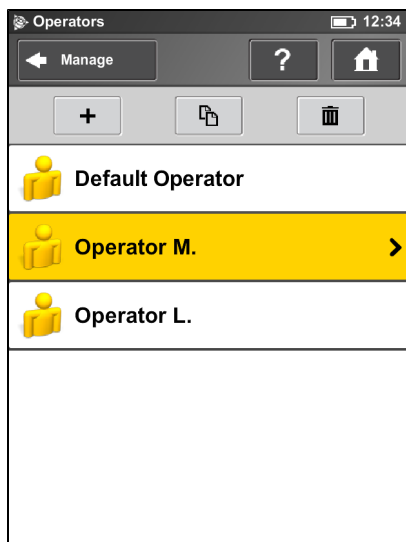
Department – The department the operator works for.

Phone – The operator's phone number.


Email – The operator's email address.

Info – Any additional information required by the service provider. This may be shift leaders, project managers etc.

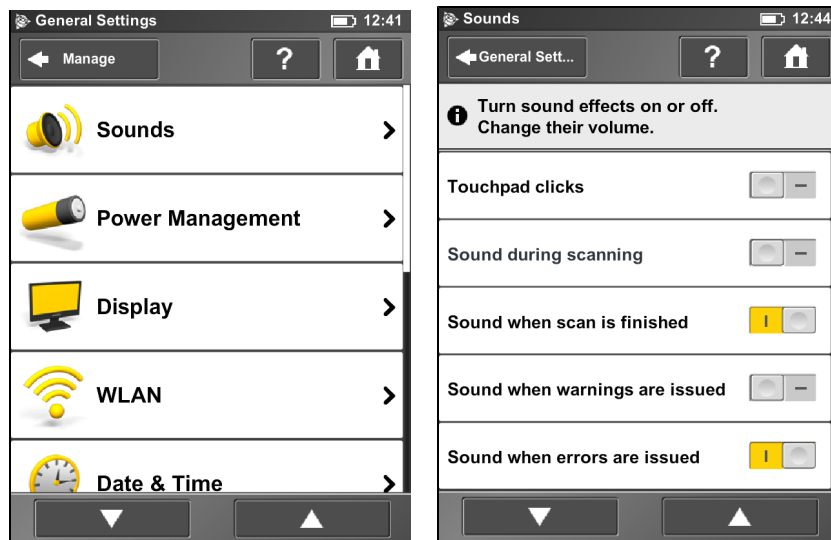
Selecting an operator



To select an operator, tap it in the list. The selected operator is assigned the next captured scans until another operator is selected. To view or edit details of the selected operator, tap it again.

To delete an operator, tap it and then tap the Delete button .

General settings



Sounds – Change the volume of the scanner sounds, enable or disable scanner sounds. See [Sounds, page 76](#).

Power Management – Set up the screen saver; view the detailed battery charge state. See [Power Management, page 77](#).

Display – Set the brightness of the screen, recalibrate it or change the wallpaper of the *Home* screen. See [Display, page 77](#).

Date & Time – Change the displayed time and date format and change the date and time of the scanner. See [Setting the date and time, page 43](#).

Language – Change the language of the operating software. See [Setting the interface language, page 42](#).

Units – Change the displayed unit of lengths. See [Setting the unit of length and the temperature scale, page 45](#).

WLAN – The laser scanner has an integrated WLAN antenna that allows to remotely connect to the scanner and to control it with an external device. Tap to view and change the WLAN settings and to turn WLAN on or off. See [WLAN / Connecting to the scanner via WLAN, page 78](#).

Note – *WLAN is only officially supported on scanners with the multi-sensor package.*

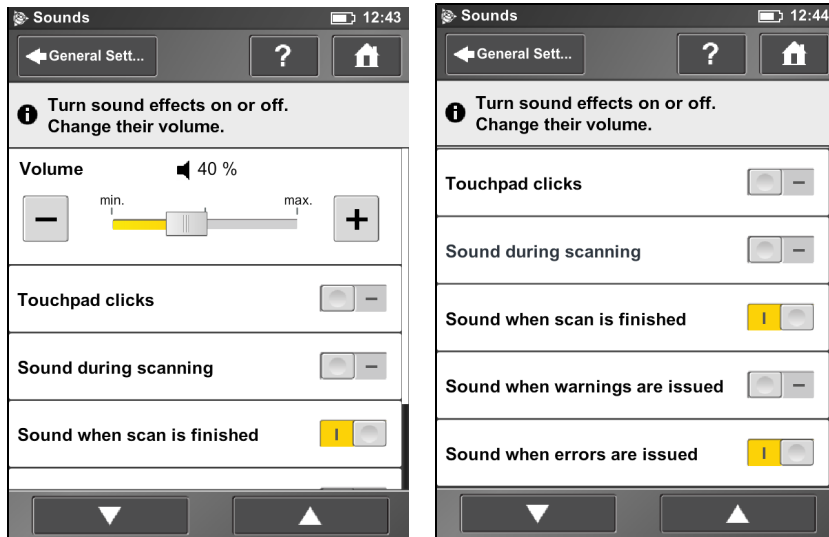
Scanner Details – View and change details of the scanner. See [Scanner Details, page 81](#).

Remote Access to Scans – Enabling this function allows access to the scans on the inserted SD card from remote devices that are connected to the scanner via WLAN or Ethernet. For more information, see [WLAN / Connecting to the scanner via WLAN, page 78](#).

Note – *The status of the SD card is set to busy when this function is enabled. Disable this function before you remove the SD card from the scanner. Remote access is automatically disabled when shutting down the scanner. You must enable it again after rebooting the scanner.*

Sounds

The scanner has a built-in loudspeaker and some scanner events are signaled by sounds. You can switch sounds on or off and change their volume.



Volume – Increase or decrease the volume of the scanner sounds.

Touch pad clicks – Switch on or switch off sound to confirm button clicks.

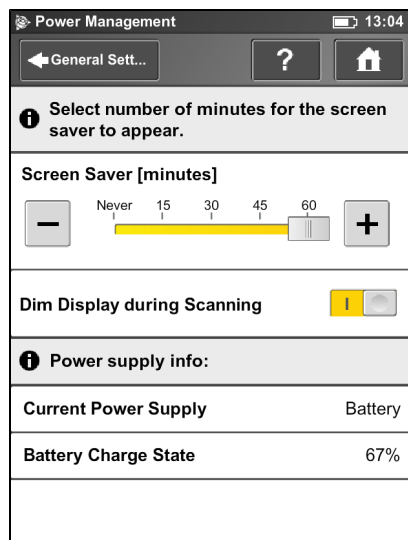
Sound during scanning – If switched on, the scanner gives a warning signal when the laser is switched on and the scanner is scanning.

Sound when scan is finished – If switched on, the scanner sounds to confirm scan completion.

Sounds when warnings are issued – If switched on, the scanner sounds when a warning is issued.

Sounds when warnings are issued – If switched on, the scanner sounds when an error is issued.

Power Management

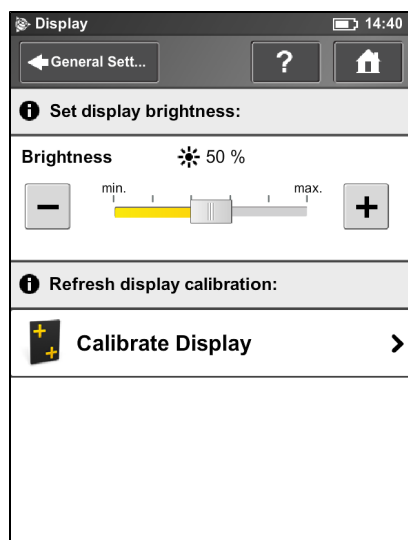


Screensaver – If the screen has not been touched for a period of time, a screensaver appears. Change the length of time before the screensaver appears by tapping the plus or minus buttons. To deactivate the screensaver, set the time to "Never". When the screensaver is visible, touch the screen to return it to operation mode.

Dim display during scanning – If switched on, the brightness of the screen decreases during scanning to save battery power. Switching this option to ON is useful for long lasting scans.

Power supply info – Informs about the current power supply and the exact charge state of the battery.

Display



Brightness – Set the brightness of the screen.

Calibrate the display – If you experience the touch screen to be slightly misaligned, you may have to recalibrate it. Tap this button and follow the instructions on the appearing screen. We recommend using a stylus to calibrate the display. If the calibration of the touch screen is corrupted so that it is unusable, you should reset the calibration of the display to its factory settings. To do this, shut down the scanner using the **Power** button. Wait until the scanner has shut down, then press and hold down the **Power** button for at least five seconds until the LED on the sensor side of the scanner illuminates yellow, then release the button again. The scanner then boots up and resets the calibration of the touch screen to its factory settings.

Change the wallpaper – Change the wallpaper of the *Home* screen. Tap to get a list of available wallpapers, which are stored on the scanner. To import new wallpapers to the scanner, use the backup option.

Date and Time

See [Setting the date and time, page 43](#).

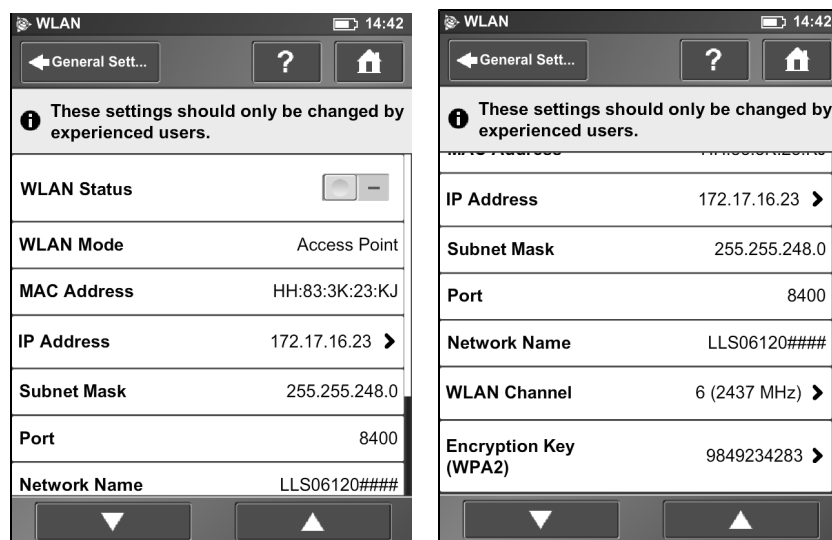
Language

See [Setting the interface language, page 42](#).

Units

See [Setting the unit of length and the temperature scale, page 45](#).

WLAN / Connecting to the scanner via WLAN



The laser scanner has an integrated WLAN antenna that allows the scanner with to remotely connect to portable devices, like notebooks, PDAs or tablet computers. Once you have connected

your remote device to the scanner via WLAN, you are able to remotely access the scanner's operating software with a standard web browser. You can also remotely access the scan files on the inserted SD card.

Note – *To run the TX5 Controller software, the web browser must support Adobe Flash.*

WLAN Status – Tap to turn WLAN on or off. If WLAN is not needed Trimble recommends turning it off.

Note – *Changes to WLAN settings are only possible if WLAN is turned off.*

WLAN Mode – The scanner's WLAN network is configured as a wireless ad hoc network.

Note – *Depending on the manufacturing date of the scanner, the WLAN might be configured as an ad hoc network.*

WLAN Mode – The scanner's WLAN network is configured as an access point.

IP address – The WLAN IP address of the scanner. If your remote device is connected to the scanner, enter this address into the address field of your web browser followed by port 8400 (e.g. 172.17.16.23:8400) to access the operating software. Tap to change the scanner's IP address.

Subnet mask – The subnet mask of the scanner's wireless network.

Port – The network port which is used for receiving requests from client hosts. When connecting to the scanner using a web browser, enter the scanner's IP address followed by this port number into the address field of the browser (see also *IP address*).

Network name – The name of the wireless network. Usually it is the scanner's serial number. In the list of wireless connections on your remote device, the TX5 3D laser scanner is listed with this name. If the scanner is not listed, refresh the network list, after some seconds the remote device should find the laser scanner and display it in the list.

WLAN channel – The channel used for the WLAN network. Tap to change it. If encountering interference from other devices, consider changing the channel to avoid it.

Note – *All WLAN devices on the network must use the same channel.*

Encryption key – The scanner's WLAN network is encrypted with this key. The encryption key is a WEP key. Enter this key on your remote device when prompted to establish the connection to the scanner. If you want to change the encryption key, tap this field and enter your own key. The key must consist of 10 arbitrary digits.

Encryption key – The scanner's WLAN network is encrypted with this key. The encryption key is a WPA2 key. Enter this key on your remote device when prompted to establish the connection to the scanner. If you want to change the encryption key, tap this field and enter your own key. The key must consist of 10 to 63 arbitrary digits.

Configuring a notebook with Microsoft Windows software

To configure a notebook running a Microsoft® Windows® operating system:

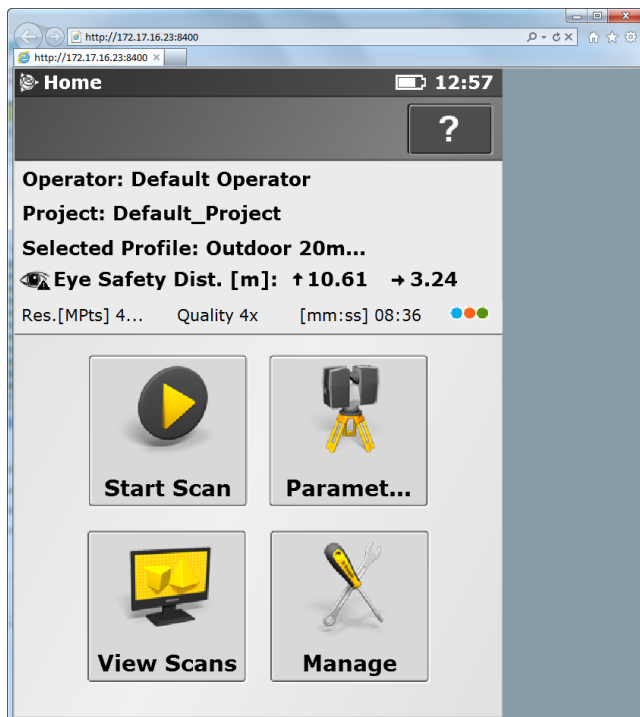
1. Do one of the following:
 - For the Windows XP operating system, right-click the wireless network icon in the taskbar and select *View Available Wireless Networks*.
 - For the Windows 7 operating system, click the WLAN icon in the taskbar.

A list with the available wireless network connections appears, including the serial number of the scanner.

2. Select the wireless network showing the scanner's serial number scanner's WLAN network. For Windows XP you must also click **Connect**.
3. When prompted, enter the WLAN encryption key. As soon as the notebook is connected to the scanner, open your web browser. In the address field of the web browser enter the WLAN IP address of the scanner followed by port 8400 (for example <http://172.17.16.23:8400>).

Note – Adobe Flash Player must be installed on your system. Make sure that you do not use a proxy server for the network connection. With some web browsers, such as Internet Explorer, it might also be necessary to allow blocked content before you can run the operating software.

The *Home* screen of the operating software appears in your web browser and you can control the scanner as usual.



Remotely accessing the scans on the SD card

To access scan files stored on the scanner's removable SD card from a connected remote device, enable the *Remote Access to Scans* option in the *Manage / General Settings* screen of the TX5 Controller software first. Then open Windows Explorer on the remote device and enter the following address into the address bar: `\\WLAN_IP_ADDRESS_OF_SCANNER\Scans` (for example `\\172.17.16.23\Scans`). You should have access to the scans now and can download them to the remote device.

Note – Copying the files from the scanner via WLAN may take a while, depending on connection speed and signal strength.

Scanner Details

Details about your scanner:	
Scanner Name	LLS06120####
Owner	Trimble
LAN IP Address	172.16.17.117
Subnet Mask	255.255.248.0
Serial Number	LLS06120####
Model	Trimble TX5
Total No. of Scans	200
ScanOpD Revision	Rev004
UI Revision	1.2.72
FPGA code Revision	Rev004
Micro Controller Revision	Rev004
Motor Controller Revision	Rev004

Scanner Name – Give your scanner a name.

Owner – Enter the owner of the scanner.

LAN IP Address – The Ethernet IP address of the scanner.

Subnet Mask – The Ethernet subnet mask of the scanner.

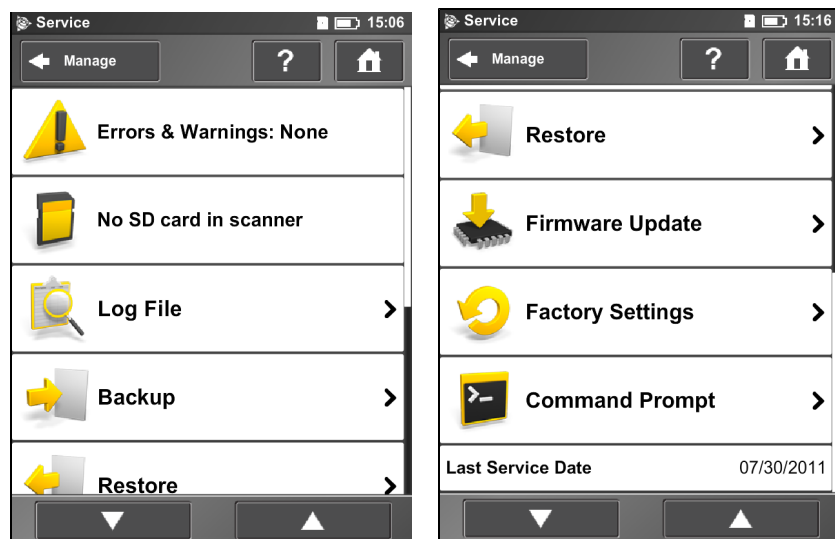
Serial Number – Serial number of the scanner. This number is individual for each scanner.

Model – The scanner type.

Total No. of Scans – The total number of scans captured with this scanner.

ScanOpD / UI / FPGA code / Micro controller / Motor Controller Revisions – The revision numbers of the scanner firmware.

Service



Errors & Warnings – Tap to change to another screen to view details of present warnings and errors. If there are no warnings or errors, tapping this field has no effect. See [Errors and Warnings, page 83](#).

SD Card – View details about the currently inserted SD card or format the SD card. See [SD Card, page 84](#).

Log file – Export the log file to the SD card. See [Log File, page 84](#).

Backup – Backup scan profiles, operators, wallpapers and scanner parameters as scanner snapshots to the SD card. See [Backup, page 85](#).

Restore – Restore scan profiles, operators, wallpapers and scanner parameters from scanner snapshots or restore scanner snapshots that have been created with TX5 SCENE software. See [Restore, page 86](#).

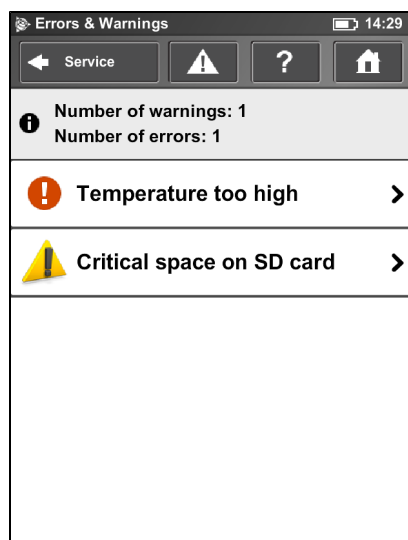
Firmware update – Update the scanner with new firmware versions. See [Firmware Update, page 87](#).

Factory Settings – Reset the scanner to its factory settings. See [Factory Settings, page 88](#).

Command Prompt – Command prompt to send commands to the scanner. This function is for Trimble Support purposes only.

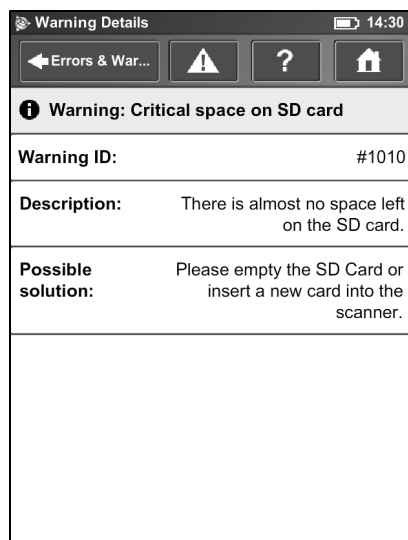
Last Service Date – Date of the last scanner maintenance and certification service.

Errors and Warnings



This view provides a list of present warnings and errors. Tap a list item to view details of the corresponding warning or error.

Warnings and errors disappear from the list when they are fixed.



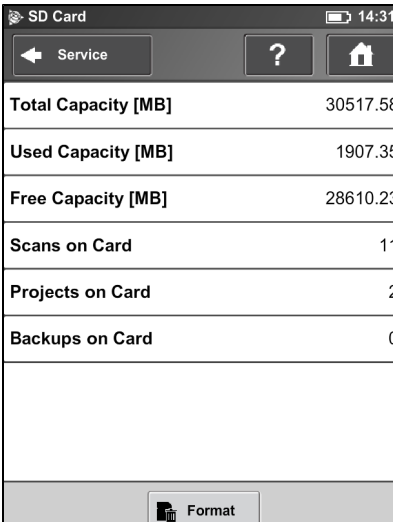
This screen shows a description of the warning or error and provides a possible solution to solve the problem.

Warning ID / Error ID – The identification number of the warning or error.

Description – A detailed description of the warning or error.

Possible solution – Possible solution to solve the problem.

SD Card



SD Card 14:31

Service ? Home

Total Capacity [MB]	30517.58
Used Capacity [MB]	1907.35
Free Capacity [MB]	28610.23
Scans on Card	11
Projects on Card	2
Backups on Card	0

Format

This view provides information about the currently inserted SD card and its contents.

Format Card – Format the inserted SD card.

Note – This operation deletes all scans and other data from the SD card. Always use the Format Card option before you begin using an SDXC card with a capacity of 64GB or more as Windows formats such cards with their own file system which is not supported by the scanner. For more information, see [Using an SD memory card, page 37](#).

Log File

Important scanner operations, sensor data as well as warnings and errors are saved to the log file to identify problems and the cause of possible errors.

Log File		15:20		
← Service	?	Home		
<div> <div></div> <div>Current log file:</div> </div>				
Size of Log File [MB]	9.54			
First Log Message	07/30/2011 14:25			
Last Log Message	08/30/2011 14:25			
Clear or export log file to SD card:				
Export	Clear			

Export – Writes the scanner log file to the SD card. It will be saved to a folder called “Logfile”.

Clear – Clears the contents of the log file on the scanner.

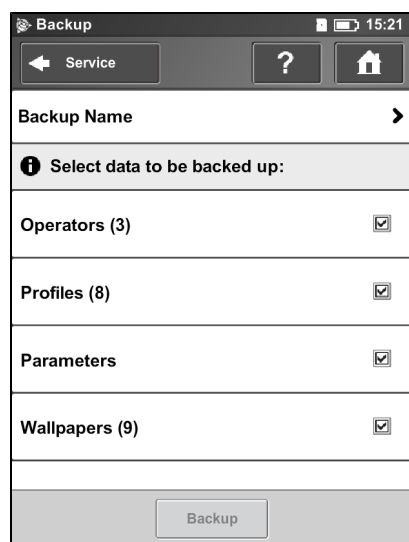
Backup

The scanner creates an automatic backup of the scanner settings and saves it to the inserted SD card. This backup is automatically updated with the current scanner settings each time you start a scan. It includes the current scan profiles, scanning parameters, operators, wallpapers and general settings.

You can create manual backups of some scanner settings including scanner parameters, operators, scan profiles, and wallpapers.

The manual backup option creates snapshots of scanner data and helps you to protect it from accidental loss if your scanner's hardware or storage media fails. It creates a duplicate copy of the data on your SD card; you can then archive the data on another storage device or modify it with TX5 SCENE software and transfer the modified data back to your scanner.

If you own more than one scanner, you can also transfer operators, scan profiles or wallpapers from one scanner to another without the need of entering the data individually.



Backup Name – Click to enter the name of the backup package. Data will be saved to the following directory on your SD card: /Backup/Your_backup_name/.

After having specified the name of the backup folder, select the data you want to backup and then tap **Backup** to start the operation.

Note – The number next to each field identifies the number of each item type on the scanner.

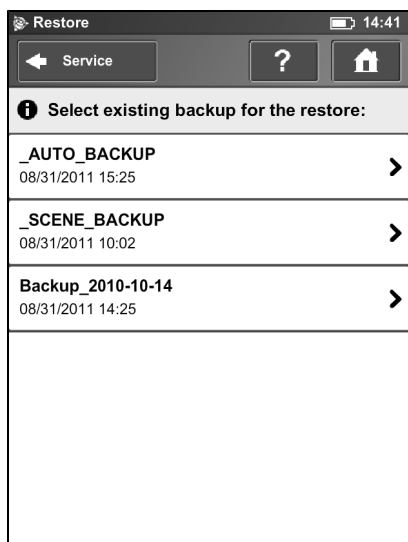
Restore

With this function you can:

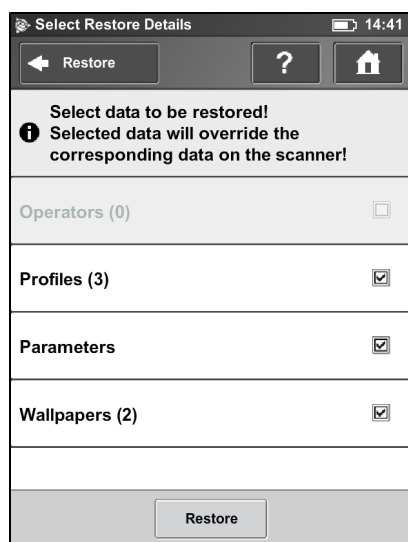
- restore operators, scan profiles, scanner parameters and wallpapers from archived backups or scanner snapshots.
- import operators, profiles and wallpapers that were created with TX5 SCENE software.
- import formerly backed up operators, profiles and wallpapers that were modified with TX5 SCENE software.
- import operators, profiles, wallpapers and scanner parameters from other scanners.

To restore data, it must be saved to an SD card. For this, create a directory on the SD card named “Backup”, and then copy the folder with the data you want to restore to this directory. If you use TX5 SCENE software to create new or modify backed up data, this is automatically done by the software.

When finished, insert the SD card with the data you want to restore.



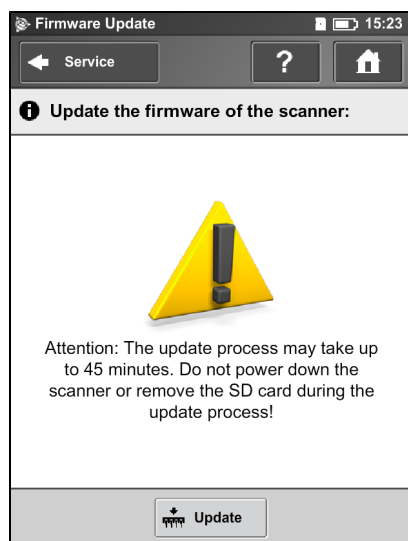
This screen shows you a list of all backup packages on the inserted SD card. **_AUTO_BACKUP** is the automatically generated scanner snapshot (see [Backup, page 85](#)). **_SCENE_BACKUP** is the scanner snapshot that has been created or modified with the TX5 SCENE software. Tap the backup package you want to restore. A new screen appears.



Select the data from the backup package you want to restore and tap **Restore** to start the restore operation.

Note – The restored data will override existing data on the scanner. For example, to restore or import scan profiles, all the existing scan profiles on the scanner are overridden by the new profiles. The scanner's default profiles remain unaffected from this operation. Trimble recommends backing up your data before restoring.

Firmware Update

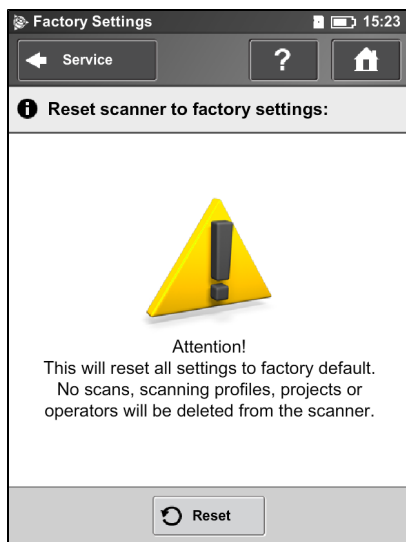


To update the firmware of your TX5 3D laser scanner you must first copy the update file to the folder "Updates" on your SD card. If this folder does not exist, create it manually.

Insert the SD card with a firmware update file, and then tap **Update**. The update process may take up to 30 or 40 minutes, depending on the extent of the update. ***Do not manually shut down or power off the scanner during the update process.***

After the update is complete the scanner might restart automatically.

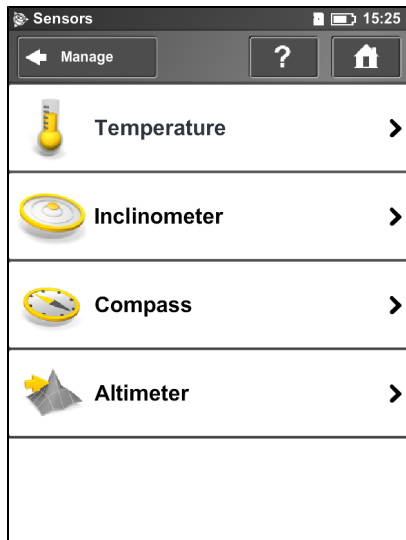
Factory Settings



This function resets your scanner settings to factory default. Use this option in exceptional cases only.

Your scans, scan profiles, scan projects or operators that are saved on the scanner remain unaffected by this operation.

Sensors



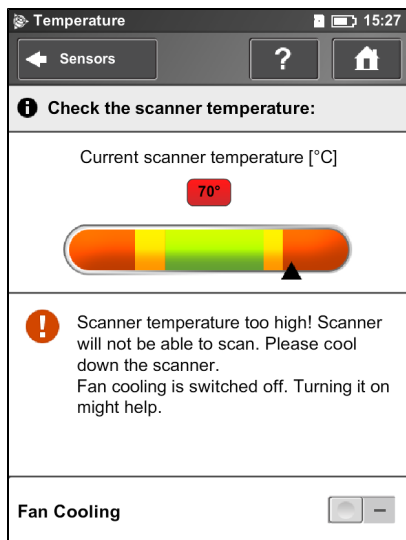
Temperature – Tap to view the current scanner temperature and to switch the scanner's fan on or off. See [Temperature Sensors](#), page 89.

Inclinometer – Tap to level the scanner. See [Inclinometer \(Dual Axis Compensator\)](#), page 90.

Compass – Tap to view the orientation of the scanner. See [Compass](#), page 91.

Altimeter – Tap to view the currently measured altitude of the scanner's position and to sync the altimeter with a reference height. See [Altimeter](#), page 92.

Temperature Sensors



The scanner has several integrated temperature sensors that measure the temperature at different positions inside the scanner. This screen shows the temperature of the sensor with the currently most critical value.

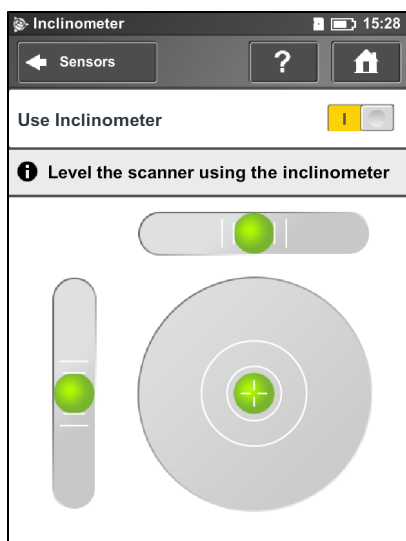
If a sensor is within a critical temperature range, just below or above a critical value, the indicator is in the yellow area; scanning is still possible, but the temperature might have a negative effect on the scan quality. Therefore, Trimble recommends warming or cooling down the scanner until the temperature indicator is within the green area.

If the temperature is too high or too low, the indicator is within the red area. In that case, scanning is not possible and the scanner will shut down within the next few minutes.

Fan cooling switches the scanner's integrated fan on or off. **Make sure the fan is switched off in exceptional cases only. If the fan is switched off for a long period of time, the scanner may overheat and abort scanning or, in the worst case, overheating may damage the scanner.**

If the temperature is above the critical limit, check the fan is switched on. If not, switch it on. The temperature should drop within a short period of time.

Inclinometer (Dual Axis Compensator)



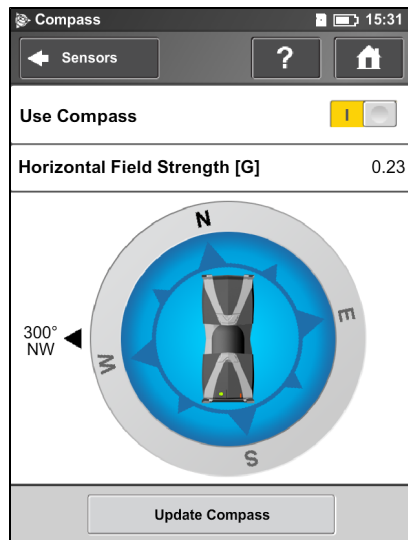
The data of the built-in dual axis compensator of the laser scanner is used to automatically level the captured scan data. The accuracy of the dual axis compensation is specified for inclinations up to 5° and degrades above 5°. The inclination of the scan is electronically measured and stored in each scan. This information is used during scan registration (for more information, refer to the *Trimble TX5 SCENE Software User Guide*). Trimble recommends leveling the scanner with an inclination less than 5°. To do this, use a bubble inclinometer at the tripod or the inclinometer screen. If you want the TX5 SCENE software to automatically use the inclination data for the scan registration, switch the **Use Inclinometer** button to ON, else switch it to OFF. This setting affects the current scanning parameters and has the same function as the equivalent button in the parameters settings. See [Setting the scan parameters, page 46](#).

The view displays 3 bubble levels as they would appear if mounted on top of the scanner. If the bubble is inside the inner black circle of the circular level, the scanner is leveled with a vertical

scanner's pan axis. If the bubble is inside the larger black circle, the inclination of the scanner is within 5° and the background color of the level is green. If the inclination is larger, the background color of the level turns red and the accuracy of the inclination measurement might then be reduced.

The two linear levels help to understand the direction of inclination: If the bubble in the upper level is on the left side, the scanner is tilted to the right (if you are standing in front of the display). If the scanner is tilted towards you, the bubble in the left level is in the upper half.

Compass



The built-in electronic compass measures the orientation of the scanner on the earth's surface. This information is attached to each scan and can be used during scan registration (for more information, refer to the *Trimble TX5 SCENE Software User Guide*). If you want the TX5 SCENE software to automatically use the compass data during scan registration, switch the **Use Compass** button to ON, else switch it to OFF. This setting affects the current scanning parameters and has the same function as the equivalent button in the parameters settings. See [Setting the scan parameters, page 46](#).

To see the current orientation of the scanner, tap the **Update Compass** button. For the measurement, the scanner needs to turn horizontally by 360°. Make sure that the scanner can move freely and do not sway the scanner during the measurement.

As soon as the scanner has completed the rotation and determined its orientation, a compass is displayed as it would appear if mounted on top of the scanner. The compass illustrates the current scanner orientation and the measured orientation value is displayed in degrees. The given orientation refers to the direction to which the scanner's left side is currently facing (the left side if you are standing in front of the scanner's display).

To get updated orientation data, for example if the scanner has been moved to another position, tap **Update Compass** again.

This manual compass measurement only affects the output on this screen and it is not necessary for the orientation data measured during scanning. During scanning an orientation measurement is performed automatically.

The accuracy of compass measurements can be affected by magnetic or other environmental interference. An indicator of the strength of environmental interference and thus of the current compass measurement accuracy is the displayed **Horizontal field strength** of the magnetic field. The typical strength of the earth's magnetic field depends on geographical position and varies from 0.3 to 0.6 gauss (G). The displayed horizontal field strength is lower than the absolute field strength because of the inclination of the field. For example, the typical horizontal field strength for Europe is about 0.2 gauss.

If the measured field strength differs a lot from the expected field strength there might be a strong artificial magnetic field near the scanner that probably affects the measurement. To get the most reliable orientation data for the scan registration, avoid positioning the scanner near to strong magnetic fields. If the measured horizontal field still significantly differs, you can switch the use of the compass data to OFF.

Altimeter

Altimeter	
← Sensors	?
Use Altimeter	<input checked="" type="checkbox"/>
Measured Height [m]	15.3
Last Sync Time	08/30/2012 09:30
Last Synced Reference Height [m]	0.0
Reference Height [m]	0.0 ▶
<p>❗ Sync altimeter with reference height:</p> <p>Sync Reference Height</p>	

The barometric height sensor (altimeter) determines the altitude of the current scanner position. The altitude determination is based on the measurement of the atmospheric pressure. The measured altitude is attached to each scan and can be used for scan registration (for more information, refer to the *Trimble TX5 SCENE Software User Guide*). If you want the TX5 SCENE software to automatically use the measured altitude for the scan registration, switch the **Use Altimeter** button to ON, else switch it to OFF. This setting affects the current scanning parameters and has the same function as the equivalent button in the parameters settings. See [Setting the scan parameters](#), page 46.

To see the currently measured altitude on this screen, the use of the altimeter must be switched ON.

For scan registration it is sufficient to know the difference in altitude of the various scanner positions. Before starting your scan project, you should pick a position of your scanning site which you would like to use as the reference for the altitude measurements. Move the scanner to this reference position, enter any height you would like to use for this position and reset the altimeter to

this reference height by clicking on the **Sync Reference Height** button. All further altimeter measurements will then be done on the basis of this reference height.

For comparable height measurements across different projects, sync the altimeter with a real altitude. For this, pick a reference position of your scanning site where you know the approximate **altitude above sea level**. You may get this value from GPS, a topographic map, or from Google Earth.

As the altimeter determines the altitude based on the measurement of the atmospheric pressure, changes in the air pressure caused by changing weather conditions have an effect on the resulting altitude. To have precise altitude measurements, you should therefore check the reference altitude from time to time, at least at the beginning of each project day or if you experience changes in the weather. To do this, move the scanner to your reference position again and compare the altitude reading with the reference height. If there is a difference, sync the altimeter with the reference height again.

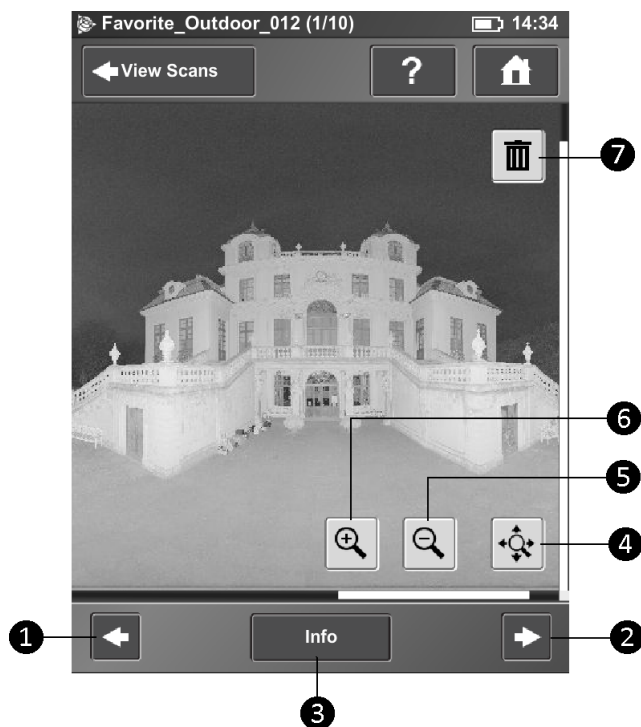
View scans

You can examine preview pictures of all the scans that have been captured and are stored on the inserted SD cards. First, a list of all available scans is displayed.



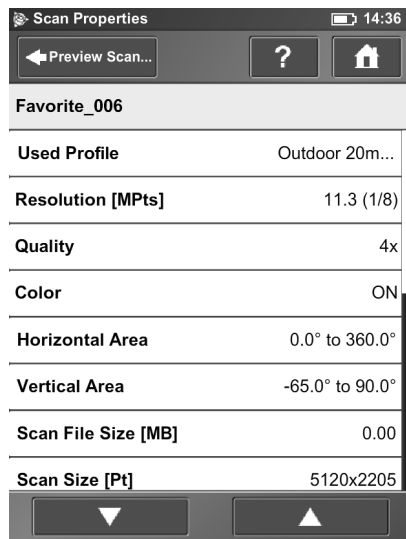
This list contains all scans that are available on the SD card, displayed with their name, file size and creation date. The list is sorted by the creation date of the scans.

Click a scan in the list to see its preview picture.



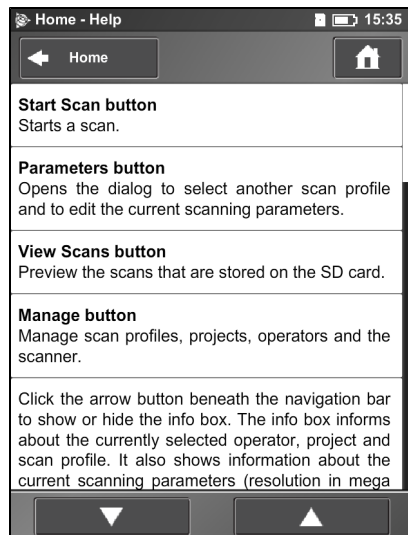
- ① **Previous** button – Shows the preview picture of the previous scan.
- ② **Next** button – Shows the preview picture of the next scan.
- ③ **Info** – Opens the *Scan Properties* screen.
- ④ **Reset zoom** button – Zooms the picture to its original size. Button is only visible if the picture is zoomed in.
- ⑤ **Zoom in** button – Zooms the picture in.
- ⑥ **Zoom out** button – Zooms the picture out.
- ⑦ **Delete** button – Deletes the currently displayed scan from the SD card.

The *Scan Properties* screen shows information about the scanning parameters that were used to capture the scan as well as the scan project, the scan operator and the name of the scanner:



Online help

You can open a description of the currently displayed view by pressing the help button in the navigation bar.



The online help provides useful information about the currently active view. It also allows you to watch the TX5 3D laser scanner video guide on the scanner's display by pressing the video guide button in the navigation bar.

Troubleshooting and Servicing

In this chapter:

- Available replacement parts
- Scanner LED behavior
- File structure of the SD memory card
- Error messages
- Mount dimensions
- Laser scanner dimensions
- Laser scanner power socket

Available replacement parts

- Power supply unit with cable
- AC power cable
- Transport case

Scanner LED behavior

	LED beneath START/STOP button	LED on mirror side of scanner	LED on sensor of scanner	LED on scanner mount
Scanner off, external power supply not connected	Off	Off	Off	Off
Scanner off, battery charging	Off	Dimmed yellow, very slow blink	Dimmed yellow, very slow blink	Dimmed yellow, very slow blink
Scanner off, battery fully charged, power supply connected	Off	Dimmed yellow, constant	Dimmed yellow, constant	Dimmed yellow, constant
Regular boot process	Yellow fast blink	Yellow fast blink	Yellow fast blink	Yellow fast blink
Low battery error during boot process	Orange fast blink	Orange fast blink	Orange fast blink	Orange fast blink
Failure during shutdown, scanner could not shut down properly (turn off scanner manually)	Orange fast blink	Orange fast blink	Orange fast blink	Orange fast blink
Scanner operable	Yellow constant	Yellow constant	Yellow constant	Yellow constant
Scan operation laser on	Red blink	Red blink	Red blink	Red blink
Scan operation laser off	Yellow blink	Yellow blink	Yellow blink	Yellow blink
Error	Orange constant	Orange constant	Orange constant	Orange constant
Shut down	Yellow fast blink	Yellow fast blink	Yellow fast blink	Yellow fast blink

File structure of the SD memory card

The file structure of the TX5 3D laser scanner SD card is as follows:

Name	Size	Type
Backup		File Folder
Logfile		File Folder
Preview		File Folder
Projects		File Folder
Scans		File Folder
Updates		File Folder
ScannerDataCard	0 KB	File

Backup – Scanner backups will be saved to this folder. The backup folder will be created automatically as soon as you start a scanner backup. See [Backup, page 85](#).

Log file – When exporting the log file from the scanner, it will be saved to this folder. This folder will be created automatically by the scanner. See [Log File, page 84](#).

Preview – The preview pictures of captured scans will be saved to this folder. The folder will be created automatically as soon as you start a scan. See [Starting a scan, page 55](#).

Projects – Scan projects information will be saved to this folder. The folder will be created automatically by the scanner. See [Managing scan projects, page 67](#).

Scans – The captured scans will be saved to this folder. The scans folder will be created automatically as soon as a scan has been started. See [Starting a scan, page 55](#).

Updates – Copy firmware updates to this folder. This folder has to be created manually. See [Firmware Update, page 87](#).

ScannerDataCard – Signature file, used to identify the SD card as a TX5 3D laser scanner card. This file will be created automatically as soon as a scan has been started.

Error messages

Error message	Description	Action
Internal Error: Invalid parameter	The scanner parameters are inconsistent.	Please restart scanner. If the problem still occurs after restart, contact Trimble Support.
Distance measurement tolerance exceeded	The white reference area on the scanner's base gave inconsistent measurements.	Please check cleanliness of this reference area, mirror, and lenses.
WLAN error	The WLAN device could not be found.	Please restart scanner. If the problem still occurs after restart, contact Trimble Support.
Color acquisition failure	Color acquisition has stopped unexpectedly. Probably color acquisition is not complete.	Please save log file and contact Trimble Support.
Out of time failure	This indicates an internal scanner error.	Please restart scanner. If the problem still occurs after restart, contact Trimble Support.
Module Status Error	Module Status Error: Data version mismatch.	Internal scanner communication problem. Please ask Trimble Support for a firmware upgrade.
Scanner Operation Failure	Internal scanner error.	Please restart scanner. If the problem still occurs after restart, contact Trimble Support.
Command not executed	Command could not be executed because of a previous running scan operation. A scan is still active, you cannot start the next operation now.	Wait until the scan has been finished.
Scanner temperature too low	Temperature of the scanner is too low. Scanning is not possible.	Please warm up the scanner before further use.
Temperature too high	Temperature of the scanner is too high. Scanning is not possible.	Please shut down the scanner and let it cool down or check if the fan is running. If not enable fan cooling under <i>Manage / Sensors / Temperature</i> .
Internal memory full	The internal scanner hard drive is full.	Please try to free some space by deleting wallpapers, operators, projects or profiles or by clearing the log file. If that does not help, please contact Trimble Support.
Possible file system corruption on SD card detected. Do you want the	The scanner has detected file system corruptions on the inserted SD card. Damages to the file system may occur when you remove the SD card from your computer without using the	It is recommended to let the scanner repair the SD card. Please note that repairing might delete erroneous files from the SD card. If you see this error message again and again, you should consider replacing the SD card. To prevent damages to the file system when removing the SD card from your

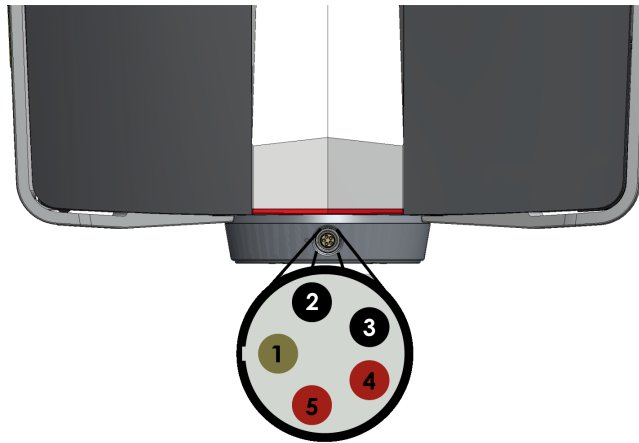
Error message	Description	Action
scanner to repair the file system on the SD card?	<i>Safely Remove Hardware</i> option in Microsoft Windows.	computer, please always use the <i>Safely Remove Hardware</i> option in Microsoft Windows.
Unknown error	An unknown error occurred.	Please restart scanner. If the problem still occurs after restart, contact Trimble Support.

Laser scanner dimensions

Dimensions are in millimeters (mm).



Laser scanner power socket



- ① Not connected
- ② GND
- ③ GND
- ④ +19V
- ⑤ +19V

Technical support

If you have a problem and cannot find the information you need in the product documentation, contact your local dealer. Alternatively, go to the Support area of the Trimble website (www.trimble.com/support/support_az.aspx). Select the product you need information on. Product updates, documentation, and any support issues are available for download.

Appendix A: Implementation Notes

The scanner's firmware includes several standard applications and libraries which are released under different licenses.

paintlib

The scanner's firmware contains paintlib code. paintlib is copyright (c) 1996-2000 Ulrich von Zadow.

libtiff

Copyright (c) 1988-1997 Sam Leffler
Copyright (c) 1991-1997 Silicon Graphics, Inc.

JPEG

The scanner's firmware is based in part on the work of the Independent JPEG Group.

KissFFT

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LGPL

The scanner's firmware includes the following applications and libraries, which are covered by the LGPL:

- libusb
- Linux API
- DirectFB

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Version 3, 29 June 2007

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Appendix B: FCC Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Class B Statement – Notice to Users. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The Federal Communications Commission warns that changes or modifications of the unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Radio Frequency Interference Statement

This is a Class B product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

Canada

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the Radio Interference Regulation of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class B prescrites dans le Règlement sur le brouillage radioélectrique.

Europe

The product covered by this guide are intended to be used in all EU member countries, Norway, and Switzerland. Products been tested and found to comply with the requirements for the following EC directives and standards:

- 2006/95/EC Low Voltage Directive
- 2004/108/EC EMC Directive
- EN 61010-1:2001, EN 60825-1:2007, EN 55011:1998 + A1:1999 + A2:2002, EN 61000-6-2:2005



Waste Electrical and Electronic Equipment (WEEE)

For product recycling instructions and more information, please go to www.trimble.com/ev.shtml.

Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power), call +31 497 53 24 30, and ask for the "WEEE Associate". Or, mail a request for recycling instructions to:

Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL



FCC Declaration of Conformity

We, Trimble Navigation Limited.

935 Stewart Drive
PO Box 3642
Sunnyvale, CA 94088-3642
United States
+1-408-481-8000

Declare under sole responsibility that DoC products comply with Part 15 of FCC Rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Expert Opinion NR. LE-G-518-2/12

Scope: Assessment of the risk for ocular injury for exposure to laser radiation from a laser scanner
(Abstract of Expert Opinion LE-G-518-1/12)


Ordered by: Trimble Navigation Limited

Address: 10355 Westmoor Drive
Westminster, Colorado 80021
USA

Test Object: Laser Scanner Trimble TX5

This expert opinion contains the pages 1 to 2

Authorized Signatory:



Dr. Georg Vees

Expert:



Dr. Karl Schulmeister

Date: 26.09.2012

Notes:

The production or transmission of extracts of the present expert opinion is subject to authorisation by the testing laboratory

This document is a summary of the Expert Opinion LE-G-518-1/12 dated Sept. 26th 2012.

In LE-G-518-1/12, the exposure levels of the eye that can be produced by the Trimble Laser Scanner TX5 are compared with injury thresholds for the retina in order to assess the risk for ocular injury when exposure occurs.

Format of decimal figures

In lieu with ISO and IEC standard regulations, a decimal comma is used here, in contrast to the usual usage of a decimal point for English texts (i.e. $\frac{1}{2}$ = 0,5 in this report, and not 0.5).

The product under assessment is laser scanner emitting a collimated laser beam in the infrared wavelength range (905 nm). The parameters of the laser product are provided by the manufacturer:

- Beam: collimated beam (low divergence of 0,16 mrad), beam diameter at mirror 2,6 mm
- Power 20 mW (quasi continuous wave)
- Rotation frequency of mirror: 3 Hz minimum; 12 Hz typical; 95 Hz maximum

Classification of the laser product according to IEC 60825-1 Ed2.0 results in **Class 3R**. The most critical condition is the slowest repetition rate (3 Hz) and exposure at 1,2 m from the scanner (so that the beam profile at the scanning mirror appears under 1,5 mrad) and accommodation of the eye so that the non-moving laser spot on the scanning mirror is imaged onto the retina (accommodation about 60 cm in front of eye). For this condition, the maximum allowed power for Class 1 equals 5,8 mW, for Class 3R it equals 29,0 mW, which results in a classification as Class 3R.

The above values are also applicable for an analysis regarding **exposure limits** that apply for the exposure of the eye of humans. For the most restrictive case of 3 Hz rotation frequency, the exposure limit of 5,8 mW is exceeded by a factor of 3,5 for an assumed exposure duration of 10 s. Due to the inherent safety margin build into the exposure limits, however, exceeding the exposure limits does not necessarily mean that an actual risk for injury exists. The risk for injury can only be characterised by comparing the exposure of the eye with injury thresholds.

The injury model that is used was validated against all available and applicable experimental injury thresholds obtained with Rhesus monkeys; this data base is the same collection of injury thresholds that forms the basis of setting international exposure limits. Appropriate reduction factors were applied to the model to result in conservative values where for exposure below these values, the possibility for injury can be regarded as negligible. For a pupil diameter of 4 mm and an assumed stationary minimal spot (possible only without spherical aberration of the eye as well as worst-case accommodation) and 10 pulses incident on the same on the retina, the predicted lower range of injury threshold equals 22 mW. The power of the laser product with 20 mW is below that value. For accommodation to the critical point, larger pupils than 5 mm are not likely, and if they were to occur, some minimal spherical aberration can be assumed, which would cause the spot on the retina to move, which increases the injury threshold. .

It can therefore be concluded that according to the current state of science and technology, exposure of the eye under normal conditions, as well as for reasonably foreseeable worst-case conditions, should not induce ocular injury.

From this biophysical point of view, it would not be necessary to wear laser eye protection (personal protective equipment), which is also the general practice for Class 3R alignment lasers in many countries. However, depending on national work place safety (health and safety at the workplace) legislation, it might be necessary to wear eye protection when the legally defined exposure limits are exceeded and when exposure can occur. Other safety measures might also be necessary according to legal requirements for work place safety (instruction of the employee, for instance), which are not the topic of this Expert Opinion. However, the level of risk as characterised in this Expert Opinion in the sense that there is *negligible foreseeable risk* for ocular injury can be an input in the risk assessment process which forms the basis for decision on necessary protective measures.

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- a description of the nonconforming Product including the model number
- an explanation of the problem

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IF YOU HAVE ENTERED INTO A SEPARATE WRITTEN LICENSE AGREEMENT WITH TRIMBLE FOR USE OF THE SOFTWARE, THE TERMS AND CONDITIONS OF SUCH OTHER AGREEMENT SHALL PREVAIL OVER ANY CONFLICTING TERMS OR CONDITIONS IN THIS AGREEMENT.

This End User License Agreement ("**Agreement**") is between Trimble Navigation Limited, located at 935 Stewart Drive, Sunnyvale, CA 94085 or its affiliates ("**Trimble**") and the customer (individual or entity) that has downloaded or otherwise procured the licensed Software (as defined below) for use as an end user ("**you**"). This Agreement covers any Software and supporting technical documentation provided with the Software ("**Documentation**").

1. Definitions.

"Effective Date" means the earlier of the date you sign an Order Form or the date on which the Software is first made available to you.

"Order Form" means any order which is entered into by Trimble (or an authorized Trimble distributor or reseller) and you under which you are provided the Software. Each Order Form for the Software shall be deemed a part of this Agreement. This Agreement is binding on you whether or not you executed an Order Form with Trimble. Order Forms may not vary the terms of this Agreement. Only a written agreement, signed by Trimble (not a Trimble distributor or reseller) may vary the terms of this Agreement.

"Software" means the Trimble software product(s) provided in connection with this Agreement in object code form (or as otherwise specified in any related Order Form). "Software" shall also include any releases provided to or purchased by you under any separate support and maintenance agreement you may enter into with Trimble. Unless otherwise noted, the Software and Documentation are referred to collectively herein as "Software."

"Third-Party Software" means any third-party software that is provided to you by Trimble under this Agreement or under separate terms and conditions.

"Trimble Supplier" means either Trimble or an authorized distributor or reseller of Trimble products or services which has entered into an Order Form with you.

2. License.

2.1. Grant of License. Subject to all of the terms and conditions of this Agreement, Trimble grants you a non-transferable, non-sublicensable, non-exclusive license to use the Software in machine-readable form on any computer and operating system for which it was intended, but solely (a) for your own internal business purposes at the location specified in the applicable Order Form (the "**Site**"); (b) in accordance with the Documentation; and (c) in accordance with any additional license term, subscription term or other user, seat, computer, field of use or other restrictions set forth in the applicable Order Form or otherwise specified upon purchase.

2.2. Installation and Copies. Trimble shall make available the Software and Documentation by disk, other media, or as embedded in a device, or make it available for download in electronic form. Trimble shall also provide you with electronic passwords or other enabling mechanisms if necessary to permit the licensed usage of the Software. All licenses shall commence, and delivery shall be deemed to occur, as of the Effective Date (or, if later, such date

on which the Software and license keys are first made available to you). If your Order Form is with a Trimble distributor or reseller, that distributor or reseller (and not Trimble) is solely responsible for delivery to you and Trimble has no liability for any failure to deliver. If the Software requires license keys to operate as licensed to you, the applicable Trimble Supplier will deliver such license keys to you.

2.3. Software Intended to be Installed on Computers. You may copy and install on your computers for use only by your employees the number of copies of the Software for which you have paid the applicable license fee. You may transfer the Software from one computer to another computer provided that the computer to which the Software is transferred is located at the Site and the Software is completely removed and de-installed from the prior computer. If you are permitted to install the Software on a network server, and you transfer the Software from the site to a new location, you must provide Trimble with written notice of the new site prior to such transfer. You may also make a reasonable number of copies of the Software for back-up and archival purposes. This Section 2.3 does not apply to any software embedded on devices.

2.4. License Restrictions. You shall not (and shall not allow any third party to): (a) decompile, disassemble, or otherwise reverse engineer the Software or attempt to reconstruct or discover any source code, underlying ideas, algorithms, file formats or programming interfaces of the Software by any means whatsoever (except and only to the extent that applicable law prohibits or restricts reverse engineering restrictions); (b) distribute, sell, sublicense, rent, lease, or use the Software (or any portion thereof) for time sharing, hosting, service provider, or like purposes; (c) remove any product identification, proprietary, copyright, or other notices contained in the Software; (d) modify any part of the Software, create a derivative work of any part of the Software, or incorporate the Software into or with other software, except to the extent expressly authorized in writing by Trimble; (e) attempt to circumvent or disable the security key mechanism that protects the Software against unauthorized use (except and only to the extent that applicable law prohibits or restricts such restrictions); or (f) publicly disseminate performance information or analysis (including, without limitation, benchmarks) from any source relating to the Software. If the Software has been provided to you as embedded in any hardware device, you are not licensed to separate the Software from the hardware device. If the Software has been provided to you separately from a hardware device but is intended to be loaded onto a hardware device specified by Trimble (such as a firmware update), your license is limited to loading the Software on the device specified by Trimble in the Documentation, and for no other use.

2.5. Evaluation Software. Subject to the terms and conditions of this Agreement and during the term of this Agreement, Trimble may, in its discretion, provide you with pre-release, beta or other software on an evaluation basis ("**Evaluation Software**"). You may use Evaluation Software solely for internal evaluation purposes for 30 days from receipt of the Evaluation Software (unless otherwise agreed by Trimble in writing) (the "**Evaluation Period**"). Unless you pay the applicable license fee for the Software, the Evaluation Software may become inoperable and, in any event, your right to use the Evaluation Software automatically expires at the end of the Evaluation Period. Evaluation Software shall be subject to all restrictions on Software set forth in this Agreement. You shall treat all Evaluation Software as Confidential Information of Trimble and shall return or destroy any copies of Evaluation Software upon expiration of the applicable Evaluation Period. Any and all suggestions, reports, ideas for improvement and other feedback of any type you provide regarding the Evaluation Software are the sole property of Trimble, and Trimble may use such information in connection with any of its products or services without any obligation or restriction based on intellectual property rights or otherwise. You acknowledge that all Evaluation Software is provided "AS IS" and may not be functional on any machine or in any environment. THE WARRANTIES OF SECTION 6 DO NOT APPLY TO EVALUATION SOFTWARE. TRIMBLE AND ITS SUPPLIERS DISCLAIM ALL WARRANTIES RELATING TO THE EVALUATION SOFTWARE, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE OR NON-INFRINGEMENT.

3. Ownership. Notwithstanding anything to the contrary contained herein, except for the limited license rights expressly provided herein, Trimble and its suppliers have and will retain all rights, title and interest (including, without limitation, all patent, copyright, trademark, trade secret and other intellectual property rights) in and to the Software and all copies, modifications and derivative works thereof (including any changes which incorporate any of your ideas, feedback or suggestions). You acknowledge that you are obtaining only a limited license right to the Software and that irrespective of any use of the words "purchase", "sale" or like terms hereunder no ownership rights are being conveyed to you under this Agreement or otherwise.

4. Payment. You shall pay all fees associated with the Software licensed and any services purchased hereunder as set forth in the applicable Order Form. All payments shall be made in U.S. dollars within thirty (30) days of your receipt of the applicable invoice, unless otherwise specified in writing by the Trimble Supplier. Except as expressly set forth herein, all fees are non-refundable once paid. You shall be responsible for all taxes, withholdings, duties and levies arising from the order (excluding taxes based on the net income of the Trimble Supplier). Any late payments shall be subject to a service charge equal to 1.5% per month of the amount due or the maximum amount allowed by law, whichever is less.

5. Term of Agreement.

5.1. Term. This Agreement is effective as of the Effective Date and expires at such time as all license and service subscriptions hereunder have expired in accordance with their own terms (the “**Term**”). Either party may terminate this Agreement (including all related Order Forms) if the other party: (a) fails to cure any material breach of this Agreement within thirty (30) days after written notice of such breach; (b) ceases operation without a successor; or (c) seeks protection under any bankruptcy, receivership, trust deed, creditors arrangement, composition or comparable proceeding, or if any such proceeding is instituted against such party (and not dismissed within sixty (60) days)). If you have entered into a separate written agreement with Trimble which governs the Software and that agreement is terminated, then this Agreement automatically terminates and you shall no longer have any right to use the Software. Termination is not an exclusive remedy and the exercise by either party of any remedy under this Agreement will be without prejudice to any other remedies it may have under this Agreement, by law, or otherwise. For clarity, even if you have entered into an Order Form with a Trimble distributor or reseller, Trimble is a third party beneficiary to that Order Form and has the right to terminate this Agreement as set forth in this Section 5 (Term of Agreement).

5.2. Termination. Upon any expiration or termination of this Agreement, you shall cease any and all use of any Software and Evaluation Software and destroy all copies thereof and so certify to Trimble in writing.

5.3. Survival. Sections 2.4 (License Restrictions), 3 (Ownership), 4 (Payment), 5 (Term of Agreement), 6.3 (Disclaimer of Warranties), 9 (Limitation of Remedies and Damages), 10 (Confidential Information), 11 (Export Compliance) and 12 (General) shall survive any termination or expiration of this Agreement.

6. Limited Warranty and Disclaimer.

6.1. Limited Warranty. Trimble warrants to you that for a period of ninety (90) days from the Effective Date (the “**Warranty Period**”) the Software shall operate in substantial conformity with the Documentation. Trimble does not warrant that your use of the Software will be uninterrupted or error-free or that any security mechanisms implemented by the Software will not have inherent limitations. Trimble’s sole liability (and your exclusive remedy) for any breach of this warranty shall be, in Trimble’s sole discretion, to use commercially reasonable efforts to provide you with an error-correction or work-around which corrects the reported non-conformity, or if Trimble determines such remedies to be impracticable within a reasonable period of time, to refund the license fee paid for the Software. A Trimble Supplier other than Trimble may fulfill Trimble’s warranty obligations hereunder on behalf of Trimble. Trimble Suppliers shall have no obligation with respect to a warranty claim unless notified of such claim within the Warranty Period.

Because the Software is inherently complex and may not be completely free of nonconformities, defects or errors, you are advised to verify your work. Trimble does not warrant that the Software will operate error free or uninterrupted, that it will meet your needs or expectations, that all nonconformities can or will be corrected, or the results obtained through use of the Software.

6.2. Exclusions. The above warranty shall not apply: (a) if the Software is used with hardware or software not specified in the Documentation; (b) if any modifications are made to the Software by you or any third party; (c) to defects in the Software due to accident, abuse or improper use by you; (d) to Software provided on a no charge or evaluation basis; (e) to any Third Party Software; or (f) to any Software obtained as freeware, whether from Trimble, a Trimble Supplier or otherwise.

6.3. Disclaimer of Warranties. THIS SECTION 6 IS A LIMITED WARRANTY AND, EXCEPT AS EXPRESSLY SET FORTH IN THIS SECTION 6, THE SOFTWARE AND ALL SERVICES ARE PROVIDED “AS IS.” NEITHER TRIMBLE NOR ITS SUPPLIERS MAKES ANY OTHER WARRANTIES, CONDITIONS OR UNDERTAKINGS, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO WARRANTIES OF TITLE, MERCHANTABILITY, FITNESS FOR A

PARTICULAR PURPOSE OR NONINFRINGEMENT. YOU MAY HAVE OTHER STATUTORY RIGHTS. HOWEVER, TO THE FULL EXTENT PERMITTED BY LAW, THE DURATION OF STATUTORILY REQUIRED WARRANTIES, IF ANY, SHALL BE LIMITED TO THE LIMITED WARRANTY PERIOD. YOU ASSUME THE ENTIRE RISK AS TO RESULTS AND PERFORMANCE OF THE SOFTWARE.

7. Support & Maintenance. Trimble shall provide the support and maintenance services, if any, as separately purchased by you and specified in the applicable Order Form. All support and maintenance shall be provided pursuant to Trimble's standard service terms which are available upon request from Trimble. Trimble Suppliers may provide additional support services under separate written agreement, but Trimble is not responsible for any such support unless it is the contracting party.

8. Professional Services. The Trimble Supplier shall provide the number of person-days, if any, of professional consulting services ("**Professional Services**") purchased in the applicable Order Form and related Statement of Work. If Trimble is providing Professional Services, unless agreed in a separate written agreement all Professional Services shall be provided pursuant to Trimble's standard service terms which are available upon request from Trimble. If your Order Form is with a Trimble Supplier other than Trimble, that party (and not Trimble) is solely responsible for providing Professional Services and Trimble has no liability related to such services.

9. Limitation of Remedies and Damages.

9.1. NEITHER TRIMBLE NOR TRIMBLE'S SUPPLIERS SHALL BE LIABLE FOR ANY LOSS OF USE, LOST DATA, FAILURE OF SECURITY MECHANISMS, INTERRUPTION OF BUSINESS, OR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY KIND (INCLUDING LOST PROFITS), REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, EVEN IF INFORMED OF THE POSSIBILITY OF SUCH DAMAGES IN ADVANCE.

9.2. NOTWITHSTANDING ANY OTHER PROVISION OF THIS AGREEMENT, TRIMBLE AND ITS SUPPLIERS' ENTIRE LIABILITY TO YOU UNDER THIS AGREEMENT SHALL NOT EXCEED THE AMOUNT ACTUALLY PAID BY YOU TO TRIMBLE UNDER THIS AGREEMENT.

9.3. THE SOFTWARE IS NOT FAULT TOLERANT AND IS NOT DESIGNED, MANUFACTURED OR INTENDED FOR USE IN LIFE SUPPORT, MEDICAL, EMERGENCY, MISSION CRITICAL OR OTHER STRICT LIABILITY OR HAZARDOUS ACTIVITIES ("HIGH RISK ACTIVITIES"). TRIMBLE SPECIFICALLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR HIGH RISK ACTIVITIES. YOU REPRESENT AND WARRANT THAT YOU WILL NOT USE THE SOFTWARE (OR PERMIT IT TO BE USED) FOR HIGH RISK ACTIVITIES, AND AGREE THAT TRIMBLE WILL HAVE NO LIABILITY FOR USE OF THE SOFTWARE IN HIGH RISK ACTIVITIES. YOU AGREE TO INDEMNIFY AND HOLD HARMLESS TRIMBLE FOR ANY DAMAGES, LIABILITIES OR OTHER LOSSES RESULTING FROM SUCH USE.

9.4. The parties agree that the limitations specified in this Section 9 will survive and apply even if any limited remedy specified in this Agreement is found to have failed of its essential purpose.

10. Confidential Information. Any software, documentation or technical information provided by Trimble (or its agents) shall be deemed "Trimble Confidential Information" without any marking or further designation. Except as expressly authorized herein, you will hold in confidence and not use or disclose any Trimble Confidential Information. You acknowledge that disclosure of Trimble Confidential Information would cause substantial harm to Trimble that could not be remedied by the payment of damages alone and therefore that upon any such disclosure by you, Trimble shall be entitled to appropriate equitable relief in addition to whatever remedies it might have at law.

11. Export Compliance. You acknowledge that the Software may be subject to export restrictions by the United States government and import restrictions by certain foreign governments. You shall not, and shall not allow any third party to, remove or export from the United States or allow the export or re-export of any part of the Software or any direct product thereof: (a) into (or to a national or resident of) any embargoed or terrorist-supporting country; (b) to anyone on the U.S. Commerce Department's Table of Denial Orders or U.S. Treasury Department's list of Specially Designated Nationals; (c) to any country to which such export or re-export is restricted or prohibited, or as to which the United States government or any agency thereof requires an export license or other governmental approval at the time of export or re-export without first obtaining such license or approval; or (d) otherwise in violation of any export or import restrictions, laws or regulations of any United States or foreign agency or authority. You agree to the foregoing and warrant that you are not located in, under the

control of, or a national or resident of any such prohibited country or on any such prohibited party list. The Software is further restricted from being used for the design or development of nuclear, chemical, or biological weapons or missile technology, or for terrorist activity.

12. General.

12.1. Assignment. This Agreement will bind and inure to the benefit of each party's permitted successors and assigns. Trimble may assign this Agreement to any affiliate or in connection with a merger, reorganization, acquisition or other transfer of all or substantially all of Trimble's assets or voting securities. You may not assign or transfer this Agreement, in whole or in part, without Trimble's written consent. Any attempt to transfer or assign this Agreement without such written consent will be null and void.

12.2. Severability. If any provision of this Agreement shall be adjudged by any court of competent jurisdiction to be unenforceable or invalid, that provision shall be limited to the minimum extent necessary so that this Agreement shall otherwise remain in effect.

12.3. Governing Law; Jurisdiction and Venue.

12.3.1. Unless you obtained this Software in Canada or the European Union, this Agreement is governed by the laws of the State of California and the United States without regard to conflicts of laws provisions thereof, and without regard to the United Nations Convention on the International Sale of Goods. In such case the jurisdiction and venue for actions related to the subject matter hereof are the State of California and United States federal courts located in Santa Clara County, California, and both parties hereby submit to the personal jurisdiction of such courts.

12.3.2. If you obtained this Software in Canada, this Agreement is governed by the laws of the Province of Ontario, Canada, excluding its rules governing conflicts of laws and without regard to the United Nations Convention on the International Sale of Goods. In such case jurisdiction and venue for actions related to the subject matter hereof are the courts of the Judicial District of York, Province of Ontario and both parties hereby submit to the personal jurisdiction of such courts.

12.3.3. If you obtained this Software in the European Union, this Agreement is governed by the laws of The Netherlands, excluding its rules governing conflicts of laws and without regard to the United Nations Convention on the International Sale of Goods. In such case each jurisdiction and venue for actions related to the subject matter hereof are the courts of The Hague, The Netherlands and both parties hereby submit to the personal jurisdiction of such courts.

12.4. Attorneys' Fees and Costs. The prevailing party in any action to enforce this Agreement will be entitled to recover its attorneys' fees and costs in connection with such action.

12.5. Notices and Reports. Any notice or report hereunder shall be in writing. If to Trimble, such notice or report shall be sent to Trimble at the address above to the attention of "Legal Department". If to you, such notice or report shall be sent to the address you provided upon placing your order. Notices and reports shall be deemed given: (a) upon receipt if by personal delivery; (b) upon receipt if sent by certified or registered U.S. mail (return receipt requested); or (c) one day after it is sent if by next day delivery by a major commercial delivery service.

12.6. Amendments; Waivers. No supplement, modification, or amendment of this Agreement shall be binding, unless executed in writing by a duly authorized representative of each party to this Agreement. No waiver will be implied from conduct or failure to enforce or exercise rights under this Agreement, nor will any waiver be effective unless in a writing signed by a duly authorized representative on behalf of the party claimed to have waived.

12.7. Entire Agreement. This Agreement is the complete and exclusive statement of the mutual understanding of the parties and supersedes and cancels all previous written and oral agreements and communications relating to the subject matter of this Agreement. No provision of any purchase order or in any other business form employed by you will supersede the terms and conditions of this Agreement, and any such document issued by a party hereto relating to this Agreement shall be for administrative purposes only and shall have no legal effect. **Notwithstanding the foregoing, if you have entered into a separate written license agreement signed by Trimble for use of the Software, the terms and conditions of such other agreement shall prevail over any conflicting terms or conditions in this Agreement.**

12.8. Independent Contractors. The parties to this Agreement are independent contractors. There is no relationship of partnership, joint venture, employment, franchise or agency created hereby between the parties. Neither party will have the power to bind the other or incur obligations on the other party's behalf without the other party's prior written consent.

12.9. Force Majeure. Neither party shall be liable to the other for any delay or failure to perform any obligation under this Agreement (except for a failure to pay fees) if the delay or failure is due to unforeseen events, which occur after the signing of this Agreement and which are beyond the reasonable control of the parties, such as strikes, blockade, war, terrorism, riots, natural disasters, refusal of license by the government or other governmental agencies, in so far as such an event prevents or delays the affected party from fulfilling its obligations and such party is not able to prevent or remove the force majeure at reasonable cost.

12.10. Government End-Users. The Software is commercial computer software. If the user or licensee of the Software is an agency, department, or other entity of the United States Government, the use, duplication, reproduction, release, modification, disclosure, or transfer of the Software, or any related documentation of any kind, including technical data and manuals, is restricted by a license agreement or by the terms of this Agreement in accordance with Federal Acquisition Regulation 12.212 for civilian purposes and Defense Federal Acquisition Regulation Supplement 227.7202 for military purposes. The Software was developed fully at private expense. All other use is prohibited.

12.11. Third-Party Software. If designated in the Documentation, the Software may contain or be provided with certain Third-Party Software (including software which may be made available to you in source code form). Such Third-Party Software is not licensed hereunder and is licensed pursuant to the terms and conditions ("**Third-Party License**") indicated in the Documentation and/or on the Third-Party Software. Except as may be set forth in the Third-Party License, neither Trimble nor Trimble Suppliers offer any warranty in connection with any Third-Party Software and neither Trimble nor Trimble Suppliers shall be liable to you for such Third-Party Software.

If an executed agreement exists between you and Trimble at any time regarding the Software, the terms of that agreement shall supersede the terms of this Agreement in its entirety. Thus, if you enter into a separate written agreement with Trimble regarding the Software, that agreement (not this one) will control your use of the Software; and further if that agreement is terminated, you will not have the right to use the Software under the terms of this Agreement after termination. Notwithstanding the foregoing, pre-printed terms and conditions on your Order form shall not supersede this Agreement.

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